EFFECT OF STOCKING DENSITY ON THE PERFORMANCE OF BEETAL KIDS UNDER STALL-FED CONDITIONS

Thesis

Submitted to the Guru Angad Dev Veterinary and Animal Sciences University in partial fulfillment of the requirements for the degree of

MASTER OF VETERINARY SCIENCE
in
LIVESTOCK PRODUCTION MANAGEMENT
(Minor Subject: Animal Nutrition)

By

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CERTIFICATE I

This is to certify that the thesis entitled **"EFFECT OF STOCKING DENSITY ON THE PERFORMANCE OF BEETAL KIDS UNDER STALL-FED CONDITIONS"** submitted for the degree of **M.V.Sc.** in the subject of **LIVESTOCK PRODUCTION MANAGEMENT** (Minor subject: **ANIMAL NUTRITION**) of the Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana is a bona fide research work carried out by **Ankaj Thakur (L-2013-V-08-M)** under my supervision and that no part of this thesis has been submitted for any other degree.

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

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CERTIFICATE II

This is to certify that the thesis entitled, **"EFFECT OF STOCKING DENSITY ON THE PERFORMANCE OF BEETAL KIDS UNDER STALL-FED CONDITIONS"** submitted by **Ankaj Thakur (L-2013-V-08-M)** to the Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, in partial fulfillment of the requirements for the degree of **M.V.Sc.** in the subject of **LIVESTOCK PRODUCTION MANAGEMENT** (Minor subject: **ANIMAL NUTRITION**) has been approved by the Student's Advisory Committee along with the Head of the Department after an oral examination on the same, in collaboration with an external examiner.

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ABSTRACT

The aim of this study was to investigate effect of different floor space allowances on the performance of Beetal kids under stall-fed conditions. Twenty four spring born Beetal kids (3 month old) were randomly divided in to four groups (n=6 each group) on the basis of space allowances i.e. 0.6 m^2, 0.7 m^2, 0.8 m^2 and 0.9 m^2 covered area and 1.2 m^2, 1.4 m^2, 1.6 m^2 and 1.8 m^2 open area per kid. The animals considered under the present study were subsequently observed for various parameters such as meteorological, daily milk, feed and fodder intake, body weight, morpho-metric measurements, behavioral observations, faecal parasitic load. The results indicated that the total DMI was not significantly affected under different treatments. However, the most of the performance parameters body weight gain (BWG),average daily gain (ADG) and Feed conversion ratio (FCR) increases with increase in space allowance, but differences did not reach the significant level ($P < 0.05$). Moving, exploring pen, grooming and resting behaviors were seen significantly higher ($P < 0.05$) in high space allowance and eating, standing and negative social interactions were seen significantly higher ($P < 0.05$) in lower floor space allowance. Higher floor space allowances tend to have lower parasitic load than lower floor space. Economic analysis indicated that performance advantage of high floor space allowance compensate for increase in housing cost and there was maximum income in 0.9 m^2 floor space allowance due to better growth of kids.

Keywords: Floor space, Beetal kids, Stall-fed, Behavior

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Signature of Major Advisor   Signature of Student

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LIST OF ABBREVIATIONS USED

ADF	:	Acid Detergent Fibre
ADG	:	Average Daily Gain
ADL	:	Acid Detergent Lignin
AIA	:	Acid insoluble ash
ANOVA	:	Analysis of Variance
BIS	:	*Bureau of Indian Standards*
ºC	:	Degree Celsius
CP	:	Crude Protein
DM	:	Dry Matter
DMI	:	Dry Matter Intake
EE	:	Ether Extract
et al	:	Et alia (and others)
FAWC	:	Farm Animal Welfare Council
FFP	:	Five Freedoms and Provisions
FCR	:	Feed Conversion Ratio
Fig.	:	Figure
GADVASU	:	Guru Angad Dev Veterinary and Animal Sciences University
gm	:	gram
kg	:	kilogram
ml	:	millilitre
N	:	Nitrogen
NDF	:	Neutral Detergent Fibre
RH	:	Relative Humidity
SPSS	:	Software Package for Social Sciences
Wt.	:	Weight

PUNCTUATION MARKS AND PROOF READING SYMBOLS

,	:	Comma
;	:	Semicolon
:	:	Colon
.	:	Full stop
-	:	Hyphen
( )	:	Parenthesis or circular brackets
_	:	Less-than or equal to
°	:	Degree
%	:	Percent
@	:	At the rate

CHAPTER I

INTRODUCTION

Goat (*Capra hircus aegarius*) is one of the earliest domesticated animals in livestock farming. It is a multifunctional animal, providing meat, milk, fibre and skin. It also gives quick returns because of short generation interval and high level of prolificacy. Goat production is suited for marginal, small as well as large scale production in tropics and sub-tropics. Goat is known as ‘Poor man’s cow’ in India and is a very important component in dry land farming system.

Present goat population of India and Punjab is 135.17 million and 327 thousand, respectively (Indian Livestock Census 2012). Due to gradual shift in goat rearing practices from extensive to intensive or stall-fed conditions, housing became one of the important input for goats. The main objective in housing the animals is to provide conditions for high productivity, health, comfort and convenience in management. The ever expanding human and animal population has put such a tremendous pressure on the available land that it has become imperative to save it to maximum extent possible, while designing animal habitations. So far, guidelines in this respect are of arbitrary nature with limited experiment basis.

Space allowance is generally defined as the average area offered per animal (Petherick 2007, Petherick and Phillips, 2009) and it is considered a defining feature of all animal production systems due to its economic implications. Space allowance generally determines the freedom of movement for confined animals. It has been suggested that animals have both qualitative and quantitative space requirements. Qualitative space is needed for occupation, social dominance, flight distance and quantitative space to achieve activities such as lying down, body care, exploration, kinetics and social behavior (Fraser and Broom, 1990). The minimum floor space for goat kid (3-6months) is 0.8 m^2 (BIS 2008). At present only small proportion of our farm animals are maintained on scientific lines. Provision of large enclosures for animal housing implies larger land requirements, higher construction and maintenance costs and possibly manpower requirements. Therefore, commercial animal production systems are usually limit, some degree of space allowance.

Stocking animals at increasingly higher densities decreases the opportunity for exercise, and choice of micro environment and social companionship. This impact on animal welfare usually precedes adverse effects on herd production and profitability. Consequently, space allowances set exclusively for economic reasons may be ethically unsound. Since inadequate space allowance can seriously compromise wellbeing even in well-managed operations, it is ethically important to set maximum housing densities for farm animals

Nowadays, one of the most widely recognized and most useful approaches to animal welfare is the definition of "The Five Freedoms and Provisions" (FFP), as defined by the Farm Animal Welfare Council (FAWC) for whom the welfare of an animal includes its physical and mental state. These freedoms identify the elements that determine the animal's own perception of their welfare state and define the provisions necessary to promote that state (Webster, 2001).

- Freedom from thirst, hunger and malnutrition by ready access to fresh water and diet to maintain full health and vigour
- Freedom from discomfort – by providing a suitable environment including shelter and a comfortable resting area
- Freedom from pain, injury and disease by prevention or rapid diagnosis and treatment
- Freedom to express normal behavior by providing sufficient space, proper facilities and company of the animal's own kind
- Freedom from fear and distress – by ensuring conditions which avoid mental suffering.

Space limitations can have negative consequences for the welfare of production animals (Fraser and Broom 1990, Estevez *et al* 2007) as well as on performance. For example, space limitations have been associated with increased behavioral problems and aggression, and a reduction of the performance in pigs (Averos *et al* 2010a,b, 2012, Gonyou *et al* 2006, Turner *et al* 2000), cattle (Ingvartsen and Andersen 1993, Krawczel *et al* 2012, Wechsler, 2011) and poultry (Bessei 2006, Cornetto *et al* 2002, Estevez 2007, Lay *et al* 2011)

Welfare standards of animals are evaluated by behavior assessments (Broom and Fraser, 2007). Andersen and Boe (2007) observed decreased lying activity with provided resting area less than 1 m^2 per goat. It may be possible that slight increase in floor space may minimize the stress level in kids which may improve welfare and performance. On the other side decreasing floor space may prove economical.

Therefore it is important to find out the effect of limited loafing area on the growth and physiological reactions of growing kids under stall-fed conditions.

A proper paramount importance is to determine management practices particularly housing systems that optimize the economic returns of the livestock farming. Intensification of animal husbandry has reduced the animal welfare standards. In the future it is likely that further intensification of animal husbandry will develop. It is therefore necessary to examine the causes and effects of such changes in order to be able to help with present and future housing design and production. Taking all these points in to consideration, the present study was undertaken with following objectives:

1. To study the performance of kids under various floor space regime.
2. To analyze welfare of kids through behavioral responses under the allotted floor space
3. To calculate the economics of raising kids under provided floor space.

CHAPTER II

REVIEW OF LITERATURE

The intensive system of livestock production has become possible because of application of recent technology. It has resulted in synthesis of superior strains of animals, but for maximum production they require balance feed, scientific management and suitable housing accommodation. The whole concept of animal husbandry system is steadily changing with the result of new innovations for the betterment of the animals in view to get maximum production from them.

Present study was designed to study performance of kids under different floor space regimes as the necessity to set minimum space allowances for confined animals has become more urgent as economic pressures have forced the use of increasingly intensive housing. As the information regarding the effect of stocking density on kids is scanty, therefore, some of the related findings in calves, lambs and pigs have also been reviewed herewith under following sub- headings:

2.1 Space allowance

2.2 Growth performance

2.3 Body measurements

2.4 Behavior

2.5 Parasitic load

2.6 Economics

2.1 Space allowance

Floor space requirement per animal (BIS, 2008)

Types of animals	**Minimum floor space per animal (m^2)**
Ram or buck in groups	1.8
Ram or buck – individual	3.2
Lambs or kids - in group	0.4
Weaner in groups	0.8
Yearling or goatlings	0.9
Ewe or doe in groups	1.0
Ewe with lamb	1.5

Fraser and Broom (1990) suggested that animals have both qualitative and quantitative space requirements. Qualitative space is needed for occupation, social dominance, flight distance and quantitative space to achieve activities such as lying down, body care, exploration, kinetics and social behavior.

Balsare and Singh (1992) suggested that floor space for kids is 0.5-1.0 m^2 and maximum animal per pen should be 20-25 while Singh *et al* (1992) reported concentration of pollutants is directly proportional to stocking density and optimum floor space for kids of 3-6 months is 0.7-0.9 m^2.

Singh *et al* (2008) recommended that to maximize survivability of kids, avoid overcrowding, kidding in conducive season, neat and dry surroundings, at least for new-born, ensure adequate colostrums / milk feeding and curative measures.

2.2 Growth performance

Gonyou *et al* (1985) found that a reducing space allowance from 0.48 m^2/lamb to 0.32 m^2/lamb resulted in a lower daily gain. Horton *et al* (1991) also reported that reducing the space allowance from 0.99 to 0.62 m^2 per lamb reduced feed intake and average daily gain. Feed efficiency also decreased when the floor space was reduced from 0.99 to 0.62 m^2 per lamb. Ingvartsen and Andersen (1993) reported that a limited space allowance results in low feed intake and daily gain worsening the feed conversion ratio of the animals.

Fisher *et al* (1997) observed that restricting space allowance for groups of housed finishing heifers primarily reduced daily gain and time spent lying down. These two measurements appear to be the most useful in evaluating the response of the heifers to crowding and both were reduced for animals at an average space allowance of 1.5 m^2. The lack of difference in daily gain and lying times between cattle at 2.0, 2.5 and 3.0 m^2 lead to conclude that a space allowance of 2.0 m^2 is adequate for heifer of this size and type for a housing duration typical of a winter finishing period.

Hyun *et al* (1998) found that in a group of growing pigs, those with a restricted space allowance (0.25 m^2/pig), grew more slowly than pigs with a greater space allowance (0.56 m^2/pig) for each week of the four weeks study and average daily gain was significantly reduced when space allowance was reduced from 0.56 m^2 to 0.25 m^2. Pigs with the restricted space allowance showed reduction in feed intake at the 4th week. Pigs with restricted floor space showed an increase uncharacteristically in the behaviors and amounts of aggression Increased aggression may also lead to increased injury levels and disease and thus, increased stress.

Wolter *et al* (2003) investigated the subsequent effects of eight weeks space restriction in weanling pigs. For eight weeks, space restricted pigs showed growth retardation when compared with pigs provided with adequate space (27.4 vs. 29.3 kg of BW).

Tapki *et al* (2006) investigated the behavior of newborn milk-fed dairy calves in different sized individual pens. Twenty-one Holstein Friesian calves were allocated to three different sized pen types (small 1 m^2×1.5 m^2, medium 1.5 m^2×1.5 m^2 and large 2 m^2× 2m^2) located in a semi open barn for 60 days following 3-day colostrum feeding. Each calf was observed twice a week for 1 h at 5 min intervals in different times of a day after the initiation of daily feeding. Animals were monitored for eating, ruminating, drinking, walking, standing, playing and resting activities. In conclusion, there was no effect of space allowance on daily live weight gain of dairy calves; but most likely, feel themselves better when kept in medium and large sized pens based on the determined behavioral results.

Van *et al* (2007) studied the effect of animal species (kids and lambs) and different group sizes on feed intake and growth, and found that increasing the number of animals in the pens increased the feed intake but did not improve growth rates or FCR probably due to aggressive behavior. In addition there is a widespread opinion among researchers that the feeding is stimulated by social facilitation, resulting in a higher feed intake when animals are not fed individually. However, the incidence of aggressive behavior was greater according to the increase in the number of animals in the stalls.

2.3 Body measurements

Petherick and Baxter (1981) found that as the body weight of Large White x Landrace pigs increased, body length, width, and height each generally increased in proportion to BW0.33 and the body area (i.e., surface area of the side of the pig) of a pig (l x w or l x h, depending on its posture) increased in proportion to the square of BW0.33, which equals BW0.67. Based on this relationship, they proposed the following equation: A=k*BW0.67, where A is the floor area (m^2) occupied by a pig, which is equivalent to body area, BW is the body weight in kg, and k is a constant which depends on the posture of the pig.

Grasso *et al* (1999) reported no influence of pen size was on somatic measurements in four groups of animals each to examine the effects of space allowance (Group A: 2.6 indoor m^2 + 2.0 outdoor m^2/calf; Group B: 2.6 indoor m^2/calf; Group C: 1.5 indoor m^2/calf; Group D: 1.0 indoor m^2/calf).

2.4 Behavior

Mogensen *et al* (1997) found that also heifers responded by reducing their lying time when the space allowance was decreased from 3.0 m^2 to 1.5 m^2 in slatted floor pens, but a similar effect could not be found in deep bedded pens.

Barroso *et al* (2000) found that the frequency of aggressive interactions was higher among goats that were kept indoors than among goats in pastures, probably because of differences in the amount of space available, which was more limited indoors. Thus, the per capita space provided to goats is critical in goat management, especially in systems in which the animals are penned. Recommended stocking densities are influenced by factors such as the age, breed, and class of stock.

Houpt (2004) reported that repeated aggression and displacements by dominant animals can cause subordinate goats to lose up to 10% of their body mass.

Loretz *et al* (2004) reported that lying time was reduced when the size of the lying area was reduced from 2.0 m^2/goat to 1.0 m^2/goat but inter-individual distances and the level of aggression remained surprisingly stable across treatments.

Boe *et al* (2006) conducted 2 x 3 factorial experiment on 24 adult ewes randomly assigned to six groups with four adult ewes in each group with pen shape (deep and wide) and lying space (0.5, 0.75 and 1.0 m^2/ewe). They observed that total lying time was reduced from 70 % to 63 % when the lying area was reduced from 1.0 m^2 to 0.5 m^2 ($P < 0.05$). Synchronisation of lying (all ewes lying simultaneously) was reduced from 45.4 % to 5.9 % ($P < 0.001$) whereas the number of displacements of lying ewes (per ewe and 24 h) increased from 6.4 to 28.9 ($P < 0.001$) as the lying area was reduced.

Caroprese *et al* (2009) observed a greater proportion of ewes walking at 3 m^2/ewe than at 1.5 m^2/ewe. The proportion of ewes walking in such study was low as compared to other behavior due to a reduction in the physical interactions among ewes under reduced space allowance.

Engeldal *et al* (2013) found significant differences ($P < 0.05$) between stocking densities for exploratory behavior, with the lowest mean rank found at the highest stocking density (0.8 m^2/animal). Rams kept at the lowest stocking density (3.2 m^2/ram), had the highest mean rank for exploratory behavior.

Averos *et al* (2014) observed higher frequencies of both positive and negative social interactions for ewes maintained at 1 m^2/ewe. In particular, most times the higher frequency of interactions between ewes at lower space allowance was positive (almost 80% of total social interactions). Therefore, it seems unlikely that space limitation resulted in reduced activity because of higher levels of social conflict per se.

Mohammed (2014) studied the effect of space allowance on behavior and performance of Egyptian Balady goats. 28 animals were divided into groups of 7 bucks with space allowances of 0.5, 1.0, 1.5 or 2.0 m^2 /buck. The most patterns of behavior were significantly affected ($P < 0.05$) by space allowance, where eating, rumination, resting and grooming behaviors were increased significantly with the increase in space allowance. Nevertheless, aggressive and walking behaviors were the highest significantly in the small floor space. The performance was increased in large space allowance, but the differences didn't reach the significance ($P < 0.05$).

2.5 Parasitic load

Panisup *et al* (1990) recorded 34% mortality in kids and 2-7% mortality in adult Pashmina goats due to coccidiosis.

Sharma and Singh (1997) reported that coccidiosis among the whole parasitic diseases has the highest mortality rate in goat kids

Balicka *et al* (2004) studied the efficacy of Toltazuril (Baycoz) on kids and adult goats suffering from coccidiosis. They reported that 85% of the adults and 100 % of the kids were infected with coccidia. The OPG count of faeces ranged 1400to 203000. Clinical symptoms were observed in 50% cases.

Khan *et al* (2011) studied the prevalence and risk factor of coccidiosis in small ruminants during hottest months (maximum mean temperature 40.7^0 C) and coldest months(minimum mean temperature 6.0^0C) of the year with an average annual rainfall of 254-381 mm. Mean OPG count was recorded highest in August (5361) which lies in rainy season in study area.

Chartier and Paraud (2012) reported that Coccidiosis is of economic importance in sheep and goat because of the losses due to clinical disease (diarrhoea) but also of subclinical infections (poor weight gain in particular). Oocyst excretion is at the around the weaning period and shows a steady decline afterwards due to a strong risk factors for high excretion include breeding intensification, high stocking in premises, poor hygiene and all causes of stress (physiological, nutritional, etc.)

2.6 Economics

Bewley *et al* (2001) reported that in spite of the impact on behavior, there is a clear economic incentive for farmers to overcrowd free-stall facilities thereby spreading the fixed costs of production over a greater number of cows without expanding existing facilities.

Wolter *et al* (2000) performed an economic comparison of nursery systems based on group sizes of 20 or 100 pigs. Surprisingly, the results suggested that the most profitable approach was to house pigs in groups of 20 rather than 100 animals. This result was largely due to the reduction in growth rate observed during the nursery period for the larger groups. Moreover, the reduced facility cost associated with larger groups had a very limited effect on total production costs on a per pig basis.

CHAPTER – III

MATERIALS AND METHODS

3.1 Experimental details

Various methodologies used during the present study had been explained herewith under different sections given below.

3.1.1 Location/Place of the work

The present experiment was conducted at Goat Research Farm, Department of Livestock Production Management, College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana

3.1.2 Experimental design

Twenty four spring born Beetal kids of about 3 month age having similar body weight were randomly divided in to four groups with 6 animals in each group as per following details

Treatment	Floor space	
	Covered area (m^2)	**Open area (m^2)**
T_0 {100% BIS recommendations (control)}	0.8	1.6
T_1 (12.5% above BIS recommendations)	0.9	1.8
T_2 (12.5% below BIS recommendations)	0.7	1.4
T_3 (25% below BIS recommendations)	0.6	1.2

The required floor space as per treatment group was allotted by using adjustable iron panels having facility of individual feeding. Rest of the management practices were same for all kids irrespective of treatments during entire study period of 3 months (July- September).

3.2 Observations recorded

3.2.1 Micro- and Macro-climate

Ambient temperature (AT ^{0}C) and relative humidity (RH %) were recorded daily at 7:30 A.M. and 2:30 P.M. Similarly, outdoor temperature and relative humidity which were recorded for the same duration at Meteorological Observatory

Fig. 3.1: Experimental pens having different floor space treatments

Fig. 3.2: Weighing of kid

Fig. 3.3: Green fodder feeding to kids

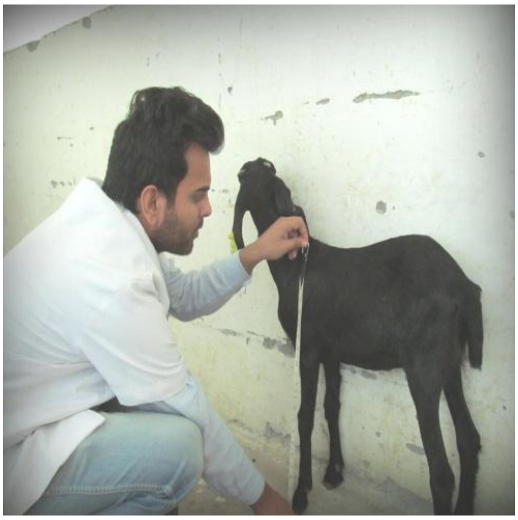


Fig. 3.4: Body measurements of kid

Fig. 3.5: Treatment of kid

of Punjab Agricultural University, Ludhiana, were utilized for comparison between micro-and macro-climate for assessing the effect of climate on animals.

3.2.2 Daily feed and fodder intake

Daily feed and fodder intake were measured by offering concentrate at 9:00 AM and fodder at 1:00 PM to each animal and taking records of daily residue in case of concentrate and roughages. Residue of feed and fodder was recorded with the help of electronic weighing balance having 1 g least count. The potable water was made available to all the kids round the clock.

3.4.3 Body weight

The kids were weighed at fortnightly intervals up to their age of 180-days. Weight of animals was taken in the morning hours before feeding and watering on a 200-kg capacity digital platform weight bridge having 50g least count (Essae DS-45).

Average daily gain: It is the rate of weight gain per day over a specified period of time. The recorded body weight was used for calculation of average daily gain (ADG) as per following formula.

$$\text{ADG (g)} = \frac{\text{Body weight gain (g)}}{\text{Interval between two BW recordings (days)}}$$

Feed Conversion Ratio (FCR): Feed conversion efficiency is expressed as feed conversion ratio (F.C.R.) and was calculated as gram of feed consumed per gram of body weight gain.

$$\text{FCR} = \frac{\text{Daily DM intake (g)}}{\text{ADG (g)}}$$

3.4.4 Body Measurements:

A flexible tape rule was used to measure the parameters *viz*. Body length (BL) distance from point of shoulder to the pin bone, height at withers (HAW) distance from the base of hoof to the highest point of withers; heart girth (HG) body circumference around the chest just behind the withers on top and just behind the elbows on the bottom (Akcapinar 2000).

3.4.5 Proximate Analysis of Feed and Fodder:

3.4.5.1 Preparation of samples

The samples of experimental diets were taken and finely ground in an electric grinder. The ground samples of the experimental diets were stored in plastic bags for analysis of proximate principles. The details of analytical procedure followed are as under AOAC (1997).

3.4.5.2 Dry matter:

A known quantity of the sample was taken in a pre-weighed dry silica crucible and dried in oven at 100^oC for overnight. The dried sample with crucible was weighed after being cooled in desiccator and dry matter was calculated as follows:

$$DM(\%) = \frac{\text{Wt. of crucible with oven dried sample} - \text{Wt. of empty crucible}}{\text{Wt. of the sample before drying}} \times 1000$$

3.4.5.3 Crude protein

Macro-Kjeldahl method was used for determination of nitrogen. A suitable quantity of finely ground material (0.2 g) was weighed and transferred into KEL PLUS® automatic extraction tube. The samples were digested with 10 ml conc. H_2SO_4 in presence of 5 g digestion mixture ($CuSO_4$:K_2SO_4:: 1:9) till appearance of light blue color. After completion of the digestion, the tube was cooled and then transferred into steam distillation tube. Then 20 ml of 40% NaOH solution was added slowly into distillation flask and ammonia was trapped in 25 ml of 4% boric acid solution with mixed indicator (10 ml/litre) in a conical flask. The ammonia borate was titrated later with 0.1 N H_2SO_4. The crude protein percentage of the sample was calculated as follows:

$$N(\%) = \frac{(\text{ml } H_2SO_4 \text{ for sample} - \text{ml } H_2SO_4 \text{ for blank}) \times \text{Strength} \times 0.014}{\text{Wt. of sample}}$$

The crude protein of feed samples was calculated with the following formula

$$CP (\%) = N(\%) \times 6.25$$

3.4.5.4 Ether extract

About 2 g of the ground sample was weighed and quantitatively transferred into a thimble which is made of Whatman filter paper no.1. The sample with thimble was transferred to the extraction beaker of SOCS PLUS® six place automatic solvent extraction system. The extraction was carried out for 2 hours with 80 ml petroleum ether (b.p 60-80^{o}C). After completion of the extraction process, the beaker was dried in the hot air oven at 100^{o}C. The ether extract was calculated as follows:

$$\text{EE}(\%) = \frac{\text{Wt. of beaker with ether extract} - \text{Wt. of empty beaker}}{\text{Wt. of the sample}} \times 100$$

3.4.5.5 Cell wall constituents:

Neutral detergent fiber and acid detergent fiber according to Van Soest and Robertson (1991).

Neutral Detergent Fibre (NDF)

Finely ground 0.5g sample was transferred in spoutless beaker and 50 ml of neutral detergent solution (weighed 18.61g disodium salt of EDTA and 6.81g sodium borate in a beaker, added some water and heated until dissolved. Weighed 4.56g disodium hydrogen orthophosphate in another beaker, added dissolved water and heated until dissolved. Add 30g sodium lauryl sulphate and 10 ml of ethoxy ethanol in 850ml distilled water. Then added contents of two previous beakers to it and mixed. Made the volume 1000ml) was added. The contents were refluxed for 60 minutes, after boiling had started. The contents were filtered through previously weighed sintered glass crucible and washed with hot water till free from neutral detergent solution followed by acetone. The residue was dried at 80^{0}C in a forced hot air oven for overnight. The difference in initial (empty crucible) and final (crucible+ residue) weight of crucible gave NDF and expressed in percent DM basis.

$$\text{NDF}(\%) = \frac{(\text{Weight of crucible + cell wall constituent}) - \text{weight of empty crucible}}{\text{Wt. of the sample on DM basis}} \times 100$$

Acid Detergent Fiber (ADF)

One gram sample was transferred in spoutless beaker and 100 ml of acid detergent solution (weight 20g CTAB and dissolved in one liter of 1N H_2SO_4).The contents were refluxed for 60 minutes, after boiling had started. The contents were filtered through previously weighed sintered glass crucible and washed with hot water till free from acid detergent solution followed by acetone. The residue was dried at 80^0C in a forced hot air oven for overnight. The difference in initial (empty crucible) and final (crucible+ residue) weight of crucible gave ADF and expressed in percent DM basis.

$$\text{ADF (\%)} = \frac{\text{(Weight of crucible + ADF) – weight of empty crucible}}{\text{Wt. of the sample on DM basis}} \times 100$$

3.4.5.6 Total Ash

Finely ground sample of about 5 to 8g was charred in a previously weighed tarred crucible on a hot plate and then ignited at 650^0C in a Muffle furnace for 3hr. The crucible were taken out, kept in a desiccator till room temperature was attained and weighted. The difference between the initial weight of empty crucible and crucible with ash gave the total ash content in the sample. The total ash (TA) content was expressed in percentage.

$$\text{Total ash (\%)} = \frac{\text{Wt. of crucible ashen crucible – Wt. of empty crucible}}{\text{Wt. of the sample}} \times 100$$

3.4.6 Behavioral Observation

To get accustomed to the different pen treatments, the groups stayed one week in each pen. Behavior was recorded (Data collection was organized) in 2 rounds per day for each observation (Half hour each). Data collection started after 10:00 am in morning and 2:00 pm in evening both 1 hour after respective meal. The method of behavioral observation was based on the methods of ‘‘scan sampling’’ (Altman, 1974) and ‘‘point sampling’’ (Fraser and Broom, 1990) with 1 minute intervals for consecutive half hour.

Ethogram used during observations {Averos *et al* (2014)} with some modifications

Behavior	Definition
Eating	Standing by the feeder, with head completely inside it
Moving	Changing position within pen, either by walking or running
Exploring pen	Nose interaction with the pen wall
Standing	Stand with the four feet on the floor, doing nothing else
Self-grooming	Groom either by self-licking or by rubbing against physical pen object
Drinking	Standing by the drinker and using it
Steriotypies	Floor kicking, pen licking
Resting	Lie down on the floor (Rest sternally, Rest laterally, Rest sternally and grooming)
Negative social interaction	Butting- sudden strong contact with other kid Threatening- directing the forehead towards another kid Displacing from resources- force another kid to leave the feeder, drinker Displacing from resting place Pushing – press the head against another kid to force the pass
Positive social interaction	Sniffing - smell another kid without physical contact Nosing - slightly contact another kid with the nose Nudging – slightly, gently pus another kid using the mouth Licking – lick any other part of kid's body
Eliminative behavior	Urinating, Defecating

3.4.7 Parasitic examination

The faecal samples were examined at monthly intervals for various coccidian oocyst. The examination of faeces was done by stoll's dilution method for quantitative examination.

In Stoll's dilution method (Soulsby, 1982) for counting Eimeria oocyst, 2 g of faeces weighed in to test tube graduated to 28 ml. The tube is then filled to the 28 ml mark with decinormal caustic soda solution and 10 to 12 glass beads are added to it. It was then closed with rubber stopper and was shaken to give a homogenous suspension of faecal material. After shaking, 0.15 ml is well mixed suspension was drawn off with a pipette graduated to this amount and placed on a slide. The total number of oocyst in 0.15 ml sample was counted and this number, multiplied by 100 gave number of oocyst in 1gram of faeces.

3.4.8 Input-output records

The economics of production was calculated on the basis of cost of inputs like feed, fodder, medicine, supplements etc. and the value of output from sale of live animals at the end of experiment. The cost of inputs and value of outputs were based on current prevailing price. Medicine cost was calculated @ Rs. 5.00/day for general ailments like diarrhoea, fever, common cold etc.

3.4.9 Statistical analysis

The collected data of different experiments was subjected to statistical analysis using Software Package for Social Sciences (SPSS version 16.0) available in the Library, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana. The recorded data were subjected to one way ANOVA (Snedecor and Cochran, 1989) to test the difference between various treatments. The significant means between different treatments were compared by Duncan Multiple Range Test (Duncan, 1995).

CHAPTER – IV

RESULTS AND DISCUSSION

The result for present experiment for the completion of this study have been presented and discussed as per the observations enlisted in chapter III. The data for ambient temperature, relative humidity , feed and fodder intake, body weight, average daily gain, FCR, body measurement, behavior, faecal parasitic load and cost of input and value of output was recorded in this experiment have been represented in Tables 4.1 to 4.10.

4.1 Meteorological Parameters

The results pertaining to micro- climate and macro- climate, during the experimental period from July 2014 to September 2014, have been presented in table 4.1. Within shed difference of 1-3 ºC whereas outside temperature ranged between 6-10 ºC for maximum and minimum temperature. It was also observed that the minimum temperature was always higher within the shed as compared to the macroclimate which may be due to heat load in the morning hours. The reversed was observed with the maximum temperature where outdoor temperature was higher. During daytime animal prevented them from direct exposure from sunlight.

Relative humidity within shed was higher in the morning than the evening hours. It was also observed that the humidity was more than 65 % in the period of July and August. The macro-RH was always higher in morning hours as compared to the micro-RH, which was indicative of better climate management within the shed. In nutshell kids during study period were under comfortable conditions.

Table 4.1: Monthly micro- and macro-climate during experimental period

Month	Temperature (°C)						Relative Humidity (%)					
	Micro-climate			Macro-climate			Micro-climate			Macro-climate		
	Min.	Max.	Mean	Min.	Max.	Mean	Mor.	Even.	Mean	Mor.	Even.	Mean
July	30.68	31.45	31.05	27.66	34.16	30.91	74.27	66.27	70.27	82.40	65.70	74.05
Aug	28.47	30.97	29.72	25.92	33.20	29.56	74.97	66.33	70.65	84.30	63.20	73.81
Sept	28.51	30.99	29.75	23.05	33.13	28.09	71.24	66.65	68.94	83.50	60.20	71.85

4.2 Daily Feed and fodder intake

The data pertaining to feed and fodder intake fed during the experimental period have been presented in Table 4.4. The concentrate feed intake was significantly higher (P<.05) in T_0 and T_1 in months of August than T_2 and T_3 and in September T_1 concentrate feed intake was higher than T_0, T_2 and T_3 groups. Overall concentrate feed intake was numerically higher (P<.05) in T_0 and T_1 groups as compared to $T_2$and $T_{3.}$

Table 4.2: Composition of composition feed (per 100 kg)

Physical components	Composition (%)
Maize	40
Soybean flakes	27
Wheat bran	18
De-oiled rice bran	12
Mineral mixture	2
Common salt (NaCl)	1

The fodder intake was significantly higher in T_1 and T_0 than, T_2 and T_3 groups in August. The overall fodder intake was higher in T_1 and T_0 than, T_2 and T_3 groups with non- significant differences among all treatment groups.

The total dry matter intake was significantly higher in T_1 and T_0 than T_3 while value of T_2 was in between the other groups in month of August. While in September T_1 has significantly higher total dry matter intake than T_2 and T_3 whereas value of T_0 falls in between the other groups.

Table 4.3: Proximate composition (%) of feed and fodder (on DM basis)

Particulars	Concentrate	Green fodder
Dry Matter	89.94	20.4
Crude Protein	20.04	08.5
Ether Extract	01.92	02.2
ADF	11.30	30.2
NDF	24.95	49.2
Total Ash	10.23	11.20

Table 4.4: Daily dry matter consumption (g/day) by the kids under different treatments

Feed and Fodder intake	Months (Year 2014)	T_0	T_1	T_2	T_3
Concentrate (gm/day)	July	325.77±9.23	330.77±8.37	319.60±9.05	313.70±9.23
	August	408.4^{a}±8.08	401.20^{a}±7.51	391.73^{ab}±8.70	372.47^{b}±9.70
	September	472.60^{b}±2.19	480.20^{a}±2.14	469.83^{b}±2.43	470.13^{b}±1.92
	Overall	402.26±7.58	404.06±7.49	393.72±7.54	385.43±8.16
Fodder (gm/day)	July	256.57±13.11	265.70±11.44	257.00±10.40	262.97±11.13
	August	351.87^{a}±7.51	366.00^{a}±6.24	322.23^{b}±9.35	300.60^{b}±10.00
	September	423.70±6.72	419.27±7.92	408.00±8.45	401.47±8.83
	Overall	342.57±8.93	345.79±8.50	329.08±8.48	321.68±8.44
Total DM	July	344.50±9.79	350.83±9.09	339.04±9.40	334.92±9.59
	August	437.93^{a}±7.86	434.28^{a}±6.766	417.00^{ab}±8.95	395.34^{b}±10.08
	September	509.19^{ab}±2.77	516.92^{a}±2.85	504.45^{b}±3.46	503.41^{b}±3.03
	Overall	430.54±8.31	434.01±8.15	420.16±8.42	411.22±8.75

Means with different superscripts in a row differ significantly ($P<0.05$)

The significant differences may be due to potentially increase in the number of interruptions during feeding; resulting in an increase in feed wastage or may be due to more body weight gain of kids in higher space allowance.

However during entire study period no difference exists for overall dry matter intake. Mohammed (2014) also observed non- significant differences in concentrate and Berseem given to goats at different space allowances (0.5m^2, 1.0 m^2, and 1.5m^2 and 2.0 m^2). Tapki *et al* (2006) found that when housing size increased from 1.5 m^2 to the larger sizes (2.25m^2 and 4.00 m^2) the calves tended to consume a higher amount of alfalfa hay without affecting their total feed intake and daily live weight gain.

Whittemore and Kyriazakis (2006) also reported that the most aggressive behavior of pigs occurs during feeding. Schmidt *et al* (2011) found that subordinate pigs displaced from feeding by aggressive males have a reduced feed intake. Douglas *et al* (2015) also reported that higher space allowance being more active and therefore have greater metabolic energy (ME) expenditure and their requirements are higher. However, the increase in the metabolic energy (ME) of diet is insufficient to compensate for their increased requirements and thus feed intake is increased to compensate it.

4.3 Growth performance of kids

The data on average body weight (kg) at fortnightly intervals has been presented in Table 4.5. There was no significant difference in body weight under different treatments.

Total gain in body weight under different space allowances during study period were 5.81 kg in T_1, 4.99 kg in T_0, 4.64 kg in T_2 and 4.05 kg in T_3. At the end of the study period, gain in body weight was higher in larger space (T_1) allowance than rest of the treatments. It may be due to higher maintenance requirement in T_1 group as compared to other groups.

Tapki *et al* (2006) also reported that calves housed in medium and large pens had opportunities to move around or showing locomotor activity. As a result, their nutrient requirements for maintenance increased and so, their final body weights were not close to those of calves housed in small pen. Mohammed (2014) also reported higher body weight gain 2.36 kg in 2.0 m^2, 2.10 kg in 1.5 m^2, 1.75 kg in 1.0 m^2 and 1.32 kg in 0.5 m^2 floor space allowances in goats.

Table 4.5: Body weight (kg) of kids at different age under various treatments

Age (Days)	T_0	T_1	T_2	T_3
90	8.82 ±0.66	8.72 ±0.55	8.12 ±0.56	8.34 ±0.52
105	9.48 ±0.77	9.64 ±0.62	8.66 ±0.78	9.69 ±0.82
120	9.88 ±0.76	10.40 ±0.70	9.22 ±0.79	9.98 ±0.89
135	10.25 ±0.68	10.92 ±0.68	9.60 ±0.66	10.19 ±1.09
150	11.73 ±0.82	12.79 ±0.81	11.35 ±0.98	11.11 ±1.46
165	12.59 ±0.92	13.57 ±0.93	11.76 ±1.15	11.69 ±1.34
180	13.81 ±1.18	14.53 ±1.05	12.75 ±1.47	12.39 ±1.39
Overall weight gain	4.99 ±0.62	5.81 ±0.58	4.64 ±1.15	4.05 ±1.02

NS= Non-significant (p<0.05)

Table 4.6: Average daily weight gain (g/d) in Beetal kids under various treatments

Age (days)	T_0	T_1	T_2	T_3
90-105	43.88 ±14.04	61.66 ±6.81	36.11 ±16.45	90.00 ±33.42
105-120	26.66^{ab} ±5.64	50.55^{a} ±10.23	37.22^{ab} ±11.20	18.88^{b} ±8.4
120-135	24.44 ±8.10	35.00±11.21	25.55 ±9.87	14.44 ±26.49
135-150	98.88 ±19.86	124.44 ±12.78	116.67±31.16	61.66 ±19.37
150-165	57.22±17.09	51.66 ±19.90	27.55 ±32.40	38.33 ±15.95
165-180	81.66 ±21.61	64.33 ±9.82	66.33 ±34.94	46.66 ±8.07
Overall	55.46 ±6.96	64.61 ±6.49	51.57 ±12.79	45.00 ±11.34

Means with different superscripts in a row differ significantly (P<0.05)

Table 4.7: Feed Conversion Ratio of Beetal kids under various weaning treatments

Age (days)	T_0	T_1	T_2	T_3
105	7.16	5.20	8.38	3.77
120	14.08	7.55	10.11	17.82
135	17.27	11.88	15.84	25.01
150	4.60	3.59	3.68	6.00
165	8.71	9.81	17.79	11.86
180	6.38	8.20	7.83	10.13
Overall	7.77	6.70	8.15	8.51

The average daily gain (ADG) during 1st month is significantly higher in T_1 group than T_3 whereas for other groups values remained in between these two groups. It might be due to more incidences of diarrhea in smaller space allowance (T_2 and T_3). Overall average daily weight gain as depicted in table indicates trend of higher growth rate in T_1 than control T_0, T_2 and T_3. Overall ADG in T_1 is 16.49 % higher than control (T_0) while in T_2 and T_3 it was 7.01% and 18.86% lower respectively than the control group. Increased feed efficiency may have increased overall ADG in larger space allowance.

Smith *et al* (1981) also reported that steers of up to 468 kg bodyweight gained 1.16 and 1.14 kg/day at space allowances of 2.32 m^2 and 1.58 m^2 respectively, but only 1.07 kg/day at a space allowance of 1.30 m^2. Fisher *et al* (1997) also mentioned that heifers at 1.5 m^2 space allowance had a lower daily live-weight gain compared with those at 3.0 m^2. Mohammed (2014) also reported non-significantly higher ADG in higher space allowance (2m^2) than lower space allowances in goats (0.5 m^2, 1.0 m^2, and 1.5m^2).

The feed conversion ratio as depicted in Table 4.7 indicated that it was better in T_1 group as compared to rest of the treatments. The high FCR in other groups may be due to diversion of energy from growth to other activities. An increase in the amount of energy expended during daily activities such as feeding and socializing when animals housed at reduced floor may have reduced their feed efficiency. The decrease in feed conversion efficiency at restricted space allowance may partly be due to increase energetic cost with longer periods of standing.

These findings were in close agreement with observation of Morrison and Prokop (1982) who recorded better feed conversion efficiency among finishing steers at 3.0 m^2 space allowance than among animals at 1.5 m^2, with no differences in feed intake. Hyun *et al* (1998) also reported decrease in feed efficiency with decreasing floor space in pigs. In contrast, others have reported no change or a slight improvement in feed efficiency as floor space decreased (Harper and Kornegay 1983, Peterson 2004).

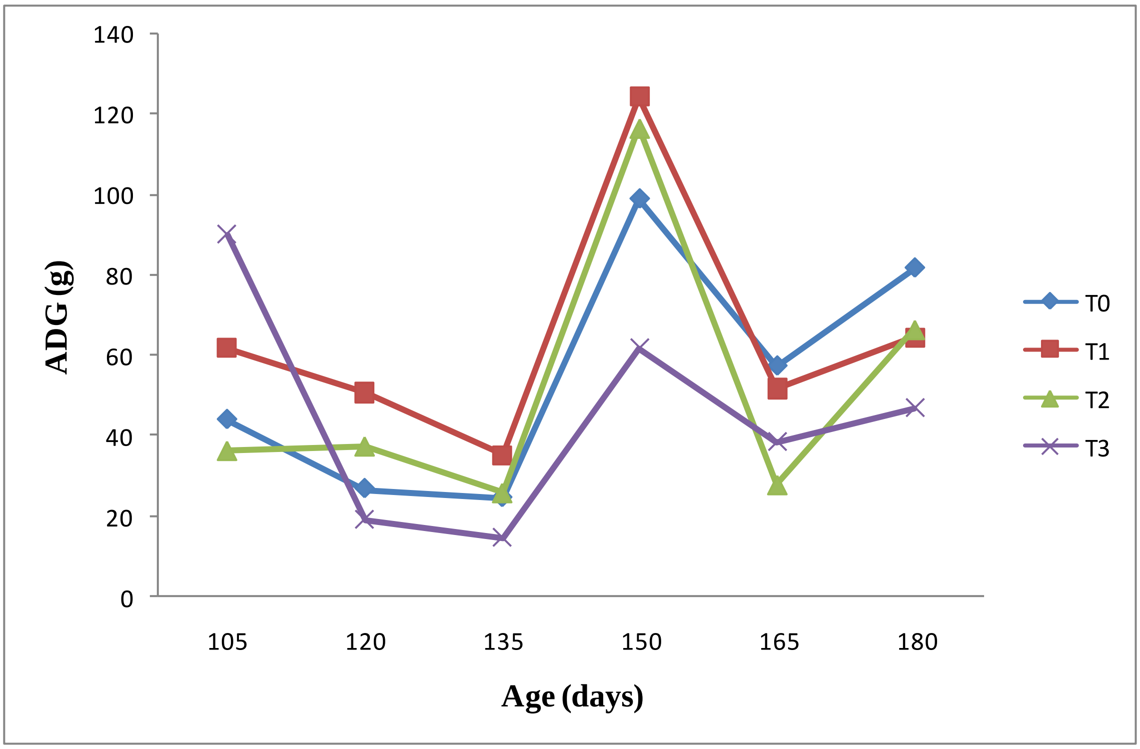


Fig 4.1: Average daily gain (g) of kids under various treatments

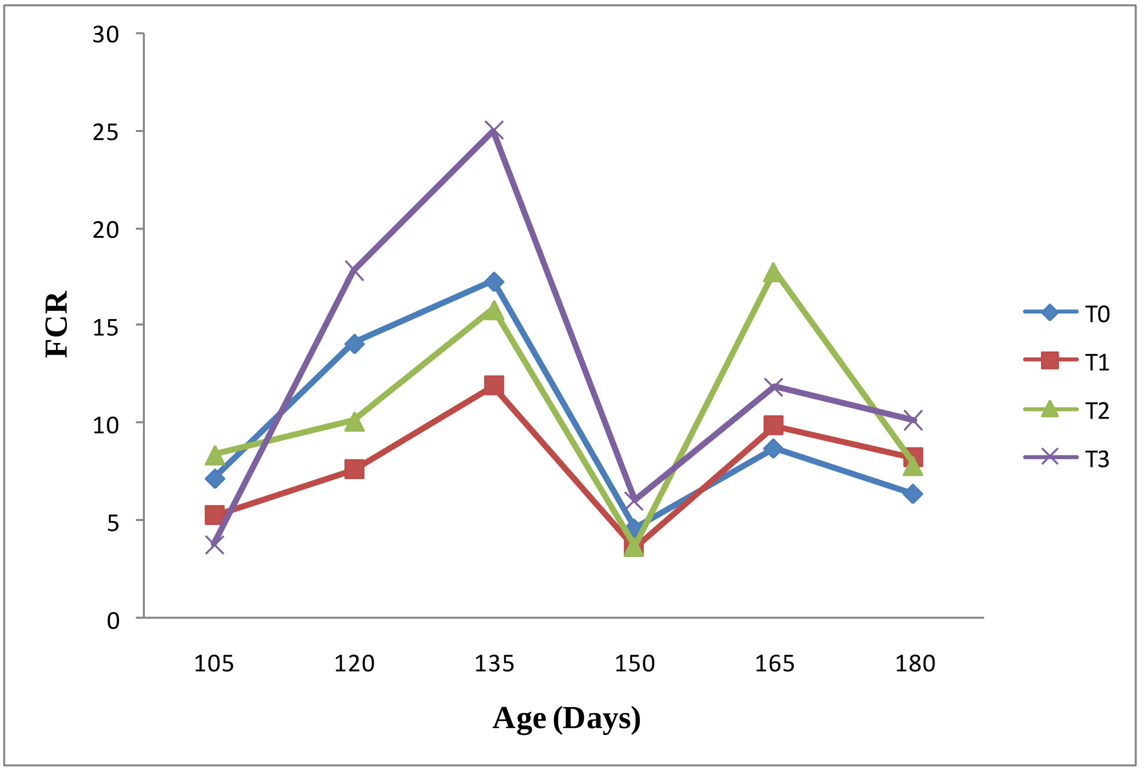


Fig 4.2: Feed conversion ratio of kids under various treatments

4.4 Morpho-metric Measurements

The data of Table 4.8 indicated that all the body measurements were non-significantly higher in T_1 (higher space allowance) than T_0, T_2 and T_3 groups. This may be due to better body weight gain in T_1 as compared to other treatments.

Petherick and Baxter (1981) also found that as the body weight of Large White x Landrace pigs increased, body length, width, and height each generally increased in proportion to BW0.33 and the body area of pig.

Cankaya and Abaci (2015) also reported that body length has highest indirect effect (0.521) on body weight and the direct effect of chest girth was higher than body length.

Table 4.8: Body measurements (cm) of Beetal kids under different treatments

Para meter	Days	T_0	T_1	T_2	T_3	Overall
Height at wither (cm)	90	50.53±1.17	51.38±1.25	49.30±0.69	49.47±1.08	50.09±0.57
	120	52.26±1.36	54.13±0.71	50.93±0.81	51.56±1.19	52.22±0.55
	150	54.63±0.81	56.00±0.59	53.63±0.99	54.13±1.24	54.60±0.47
	180	56.16±1.52	58.70±0.55	55.30±1.17	55.73±1.83	56.56±0.73
Body Length (cm)	90	47.16±0.35	47.73±1.14	46.81±1.00	47.80±.79	47.37±0.43
	120	50.60±0.78	51.60±1.05	48.66±1.16	49.60±1.07	50.11±0.53
	150	52.53±0.64	54.20±0.44	52.23±1.06	51.40±1.46	52.59±0.50
	180	56.17 ±1.52	59.06±1.06	55.30±1.17	55.73±1.83	56.56±0.73
Heart Girth (cm)	90	48.53±0.93	48.80±0.55	47.66±1.01	48.16±0.95	48.28±0.44
	120	49.33±0.88	51.16±0.92	48.73±0.74	49.26±1.00	49.62±0.45
	150	51.16±0.87	52.70±1.20	50.26±1.12	50.50±0.93	51.15±0.52
	180	54.36±1.09	56.23±1.25	53.60±1.13	53.90±2.16	54.52±0.77

NS= Non-significant (p<0.05)

4.6 Behavioral observations

Different behavioral observation has been presented in Table 4.9 and Fig. 4.4.

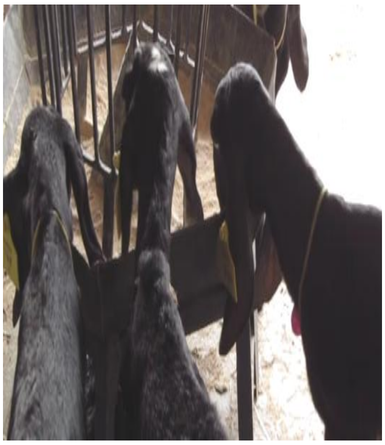
Eating

Eating was significantly different for each treatment. Kids housed at 0.6 m^2 space allowance (T_3) spent higher time as compared to other groups (Mean: 59.35%, 46.42%,65.02% and 76.07% for T_0, T_1, T_2, T_3 m^2 in morning and 51.78%, 33.57%, 55.33% and 71.78% for T_0, T_1, T_2, T_3 m^2 respectively). The increased time in smaller space allowance may be due to competition to gain access to feeder. Social facilitation may motivate goats to eat simultaneously resulting in competition and aggression which is observed more in lower space allowance (T_2 and T_3) than higher space allowances in (T_0 and T_1)

Jorgensen *et al* (2007) also observed that goats are not well synchronized in their feeding behavior, especially in a competitive environment where one dominant goat easily can monopolize the space in front of the feed barrier. In some pens the subordinate goats could feed as soon as the more dominant goats had finished, but in other groups the dominant goat would control the feed barrier area by simply lying there.

Shinde *et al* (2004) also argued that in some cases the dominant goats do not allow sub-ordinates to consume sufficient feed. Low-status goats spent less % of total observations feeding and more % of total observations queuing than high-status goats and this effect became more evident as the feeding space was restricted. Thus, the cost of increased competition is much higher for subordinates than dominants. However, Fregonesi and Leaver (2004) found that space allowance had no significant effect on feed intake or feeding time in dairy cows.

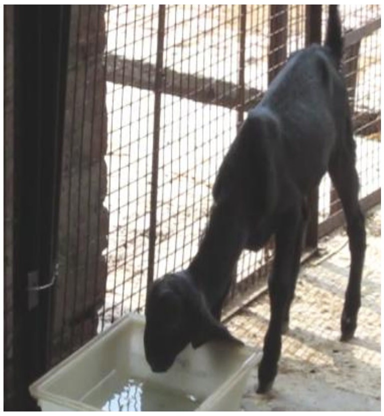
Fisher *et al* 1997 also found that heifers at 3.0 m^2 space allowance spent less time eating than heifers at 1.5 and 2.5 m^2 with length of the feed trough was constant across all treatments. Stressful conditions, such as space restriction, are known to trigger adaptations in the feeding strategies of animals, thereby negatively affecting their performance, as it has been described for growing-finishing pigs (Averós *et al* 2012).



Eating

Exploring

Moving



Drinking

Resting sternally

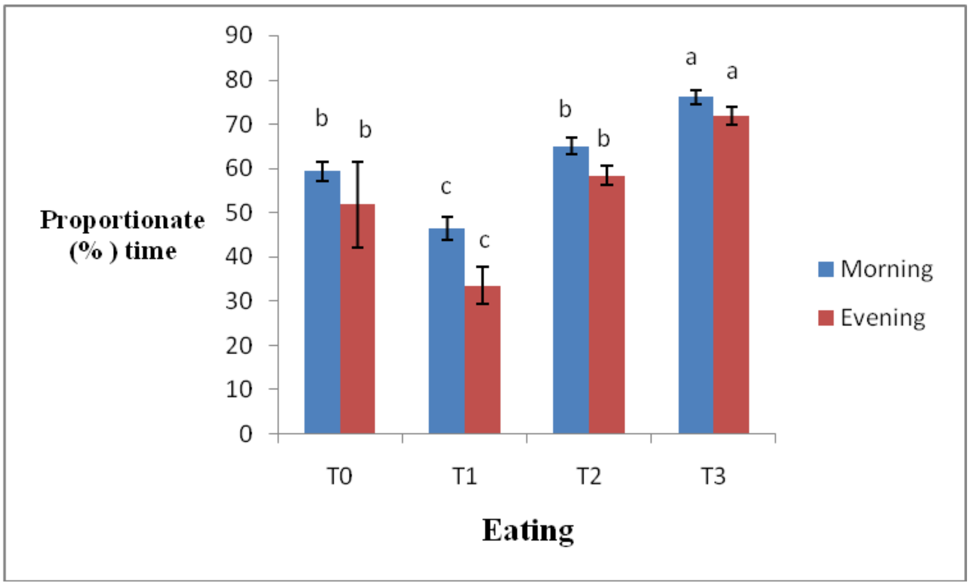
Negative social interaction

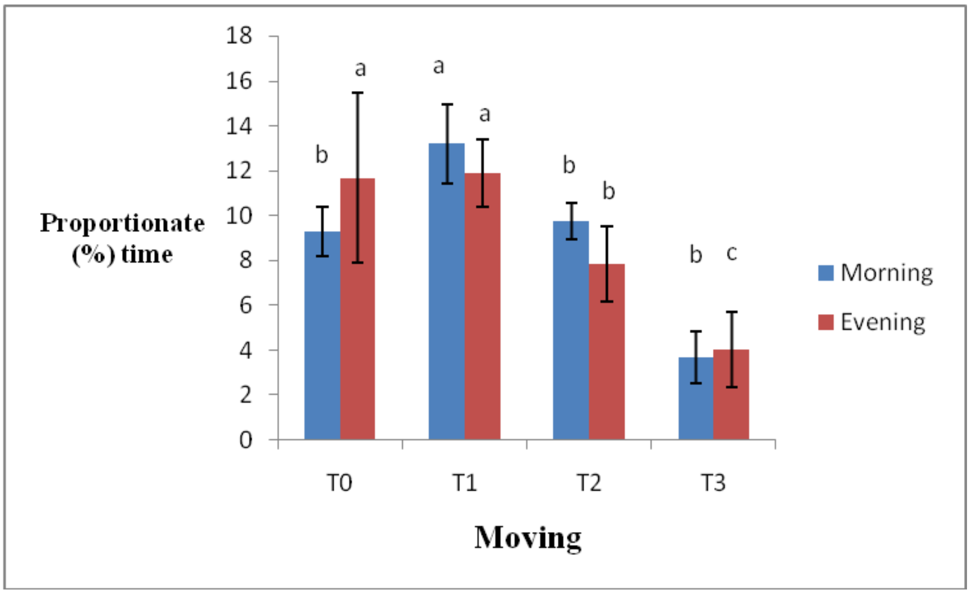
Fig. 4.3 Behavioral activities of Beetal kids used in Ethogram

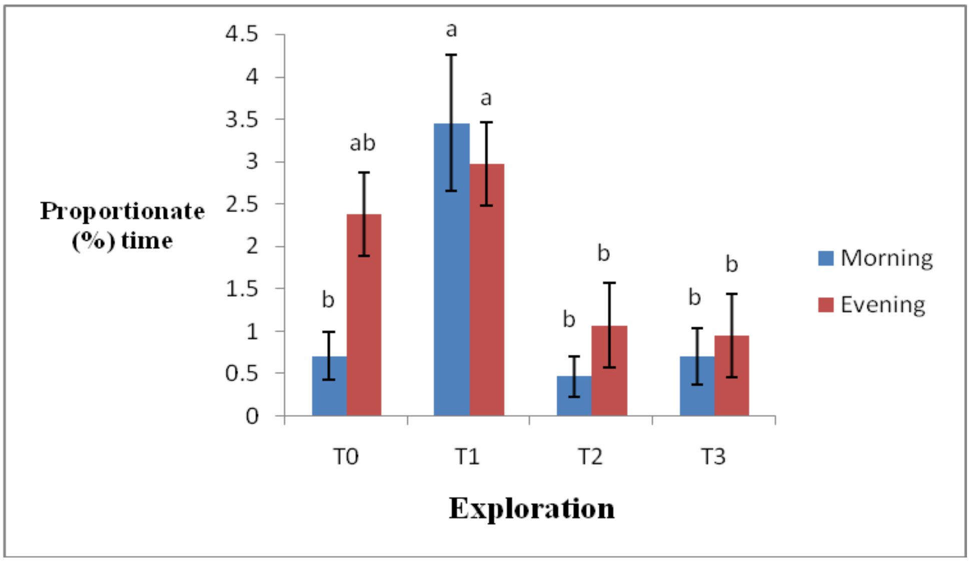
Table 4.9: Behavioral activities of kids in different floor space treatments (proportionate % time)

Behavioral activities		T_0	T_1	T_2	T_3
Eating	Morning	59.35^{b} ±2.11	46.42^{c}±2.52	65.02^{b} ±1.94	76.07^{a} ±1.65
	Evening	51.78^{b} ± 9.60	33.57^{c} ±4.27	58.33^{b} ±2.15	71.78^{a} ±2.05
Moving	Morning	9.30^{b} ±1.10	13.21^{a} ±3.17	9.73^{b} ±0.80	3.69^{c} ±1.16
	Evening	11.66^{a} ±3.78	11.90^{a} ±3.25	7.85^{b} ±1.51	4.04^{c} ±.1.69
Exploring pen	Morning	0.71^{b} ±0.28	3.45^{a} ±0.80	0.47^{b} ±0.24	0.71^{b} ±0.33
	Evening	2.38^{ab} ±0.86	2.97^{a} ±1.30	1.07^{b} ±1.21	0.95^{b}±0.22
Standing	Morning	0.59^{b} ±0.35	0.71^{b} ±0.49	2.61^{a}±0.69	3.69^{a} ±0.74
	Evening	0.59^{b} ±0.29	1.78^{ab} ±.614	2.73^{ab} ±0.64	4.04^{a} ±1.17
Self-grooming	Morning	8.80^{a} ±1.17	6.90^{ab} ±0.81	6.30^{ab} ±0.57	5.11^{b} ±0.58
	Evening	7.73 ±1.40	7.61 ±1.53	7.14 ±1.54	5.11 ±0.71
Drinking	Morning	1.42 ±0.53	1.07 ±0.56	1.42 ±0.35	2.26 ±0.23
	Evening	0.47^{b} ±0.30	0.83^{ab} ±0.25	1.07^{ab} ±0.15	1.54^{a} ±0.21
Steriotype	Morning	0.35 ±0.24	0.11 ±0.69	0.71 ±0.16	0.23 ±0.15
	Evening	0.67±0.33	1.46 ±0.23	0.27 ±0.18	0.11 ±0.08
Resting sternally	Morning	17.54^{b} ±2.89	27.26^{a} ±3.04	10.35^{bc} ±3.00	4.76^{c} ±1.94
	Evening	23.80^{b} ±2.57	39.40^{a} ±4.44	19.64^{b} ±2.63	9.76^{c} ±2.53
Resting laterally	Morning	0.35 ±0.24	0.00 ±00	0.00 ±0.00	0.00 ±0.00
	Evening	0.00 ±0.00	0.83 ±0.60	0.00 ±0.00	0.00 ±.00
Negative social interaction	Morning	0.83^{b} ±0.25	0.35^{b} ±0.24	2.85^{a} ±0.78	2.50^{a} ±0.51
	Evening	0.11^{b}±0.11	0.35^{b}±0.24	0.83^{b}±0.31	1.66^{a}±0.25
Positive social interaction	Morning	0.71 ±0.33	0.11 ±0.11	0.11 ±0.11	0.23 ±0.15
	Evening	0.23 ± 0.15	0.35 ±0.35	0.11 ±0.11	0.11 ±0.11
Urinating and defecating	Morning	0.35 ± 0.35	0.35 ±0.35	0.35 ±0.35	0.71 ±0.11
	Evening	0.47 ±0.10	0.47 ±0.19	.83 ±0.18	0.71 ±0.28

Means with different superscripts in a row differ significantly (P<0.05)


Proportionate (%) time
90
80
70
60
50
40
30
20
10
0
b b c c b b a a
T0 T1 T2 T3
Morning
Evening
Eating


Proportionate (%) time
18
16
14
12
10
8
6
4
2
0
b a a a b b b c
T0 T1 T2 T3
Morning
Evening
Moving


Proportionate (%) time
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
b ab a a b b b b
T0 T1 T2 T3
Morning
Evening
Exploration

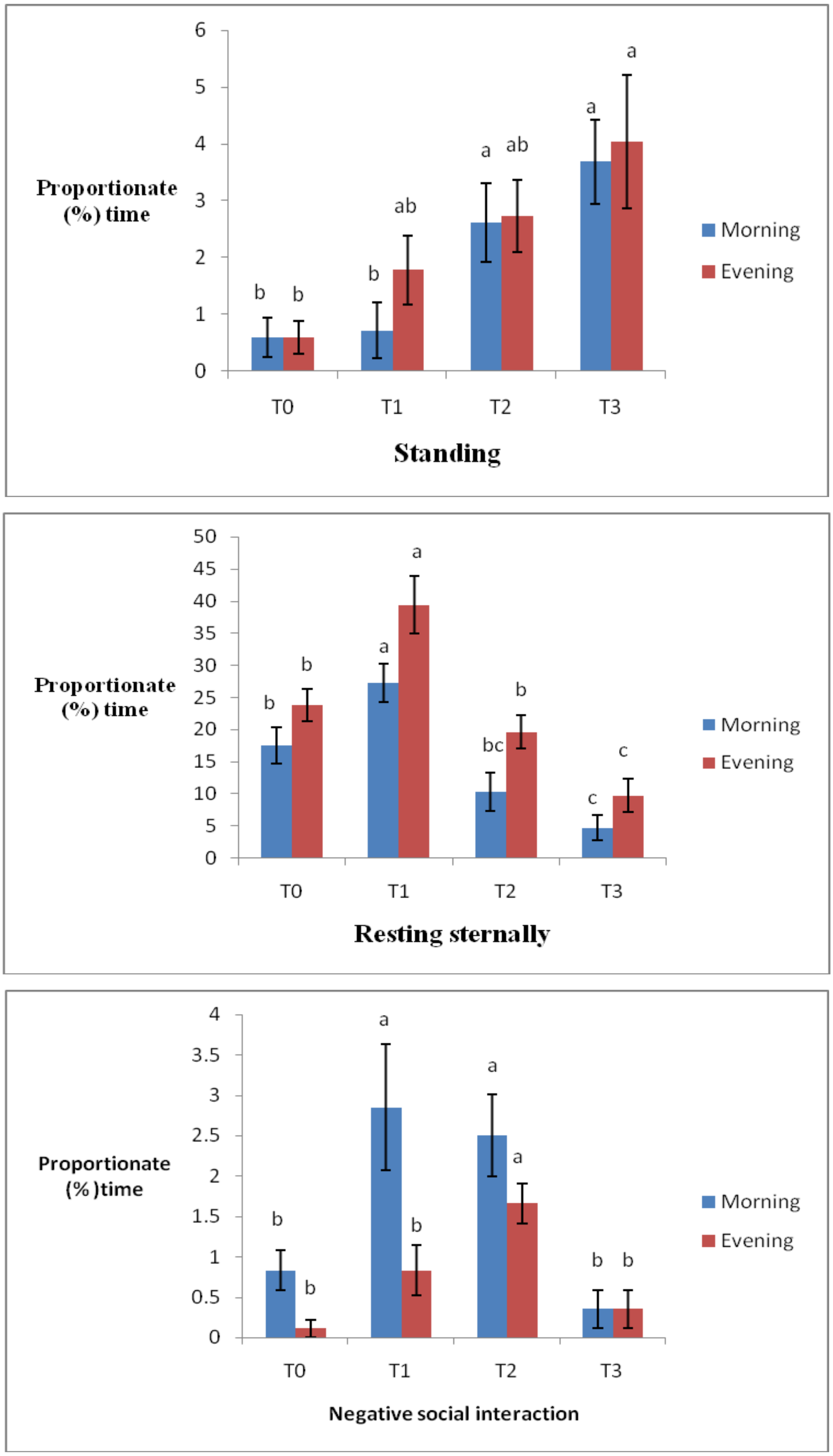


Fig 4.4: Proportionate (%) time of different behaviours depicted by kids under various treatments (P<0.05)

Moving

Time spent in moving was significantly more in higher space allowances (T_1 and T_0 group) as compared to lower space allowances (T_2 and T_3 group). It is possible that reduced movement might be caused by difficulties in movements due to the physical proximity of their pen mates, as reported by Averós *et al* (2014). A similar effect of limited space has been observed in other domestic species (Newberry and Hall 1990, Estevez *et al* 2007).These results would also agree with those of Caroprese *et al* (2009), who observed a greater proportion of ewes walking at 3 m^2 /ewe than at 1.5 m^2 /ewe. Jensen and Kyhn (2000) also observed that increased space allowances from1.5 to 4.0 m^2 per calf in group housed calves increased loco motor playing behavior of calves increased with increased space allowance until 4.0 m^2 for each calf.

Standing

Standing behavior has significant differences between the treatments. The T_3 group and T_2 have more standing time as compared to other groups (Mean 3.69%, 2.61%, 0.59% and 0.71% for 0.6, 0.7, 0.8 and 0.9 m^2 respectively in the morning. The walking activity in more pronounced in higher space allowance which might have decreased standing time. Jensen and Kyhn (2000) also observed that calves in smaller group pens performed less locomotory play and more standing than the ones kept in larger pens. Hanlon *et al* (1994) also reported that group housed animals may be induced by forced social interactions to fight or flight; therefore, standing and active behaviors may make them more prepared. It has also been reported that an increased stocking rate in swine may decrease the amount of time spent in sleeping and resting (Heitman *et al* 1961), which in turn may increase the time spent in walking or standing.

Exploration

Exploration is significantly observed more in higher space allowance (T_1 group) than the both lower space allowances (T_2 and T_3 group). At low space allowance there is low space available per animal therefore it offered physical constraints on their movement which might result in lower exploration.

Lying

Kids with lowest space allowance spent less time lying as compared to other groups. Resting sternally is observed more in T_1 and T_0 group. The goats in T_1 group rested 27.26% in morning and 39.4% in evening while in T_3 group goats rested 4.76% in morning and 9.76% in evening of the total time budget. It may be due to more discomfort and stress in goats under lower space allowance.

Fregonesi *et al* (2007) also observed that the stocking densities of 109, 120, 133, and 150% resulted in a linear reduction of lying time, relative to a 100%. Cows spent 13 h per day lying at 100%, which was reduced by approximately 2 h when stocking density reached 150%. Fregonesi and Leaver (2004) also observed that the decrease of space allowance reduces resting time and its synchrony in dairy cows.

Averós *et al* (2010a) also mentioned the importance of space allowance, among other housing aspects, on the resting patterns of animals. Loretz *et al* (2004) reported that goats spent more time in resting when space allowance was increased.

Grooming

Self grooming was observed significantly more in T_0 group than T_3 group while values of other groups fall between these two. Duncan (1998) reported that comfort behavior patterns representing in lying drowsiness, sleep, grooming behaviors were considered as indicator of animal welfare.

Hart and Pryor (2004) also reported that newborn and young goats groom more frequently than similarly maintained adults. Mohammed (2014) also found that the time spent and mutual grooming was increased linearly with the increase space allowance, where it was significantly higher in bucks at 2.0 m^2 than other groups at 0.5 m^2, 1.0 m^2 and 1.5 m^2.

Aggressive

The aggressive behavior was significantly shown higher by kids in small spaces (T_3 and T_2 group) as compared to kids in large spaces (T_0 and T_1 group). This result may be due to increased social interaction in small spaces and leading to the competition among the animals. These findings agreed with Fregonesi and Leaver (2004). Wierenga (1987) also noted increased levels of aggression among bulls at a restricted space allowance.

Drinking

Drinking is observed significantly more in T_3 group than T_1 in the evening time while the value of T_0 and T_2 falls between two with non-significantly differences between them. It may be due to close relationship between feed intake and water intake. Caroprese *et al* (2009) interpreted the highest proportion of ewes observed drinking at lower space allowance in terms of behavioral redirection, as it has also been suggested for growing-finishing pigs (Averós *et al* 2012).

According to Forkman (1996) the consumption of water is sensitive to the social behaviour in the form of competition and also social facilitation in domestic hens.

4.7 Parasitic load

Data on faecal parasitic load at monthly intervals has been presented in Table 4.10. There was significant coccidial load in T_3 group as compared to T_1 and the other T_0 and T_1 groups remained between these two groups after 1st month. It may be due to humid conditions in August which might have lead to stress in kids and made them more susceptible for coccidiosis. Later on there was decrease in coccidial count as kids might have developed resistance to coccidia.

Table 4.10: Coccidial count ($10^{3/}$ gram) in faeces of kids at monthly intervals

Age (days)	T_0	T_1	T_2	T_3
90	5.01 ±0.50	4.76 ±0.50	3.35 ±0.63	5.03 ±1.04
120	7.58^{ab} ±0.94	4.53^{b} ±0.90	8.48^{ab} ±1.85	10.61^{a} ±1.50
150	1.46 ±0.61	1.76 ±0.47	2.08 ±0.51	1.88 ±0.65
180	1.10 ±0.23	.85 ±0.19	1.11 ±0.24	1.68 ±0.37

Means with different superscripts in a row differ significantly (P<0.05)

Morbidity and Mortality

During the experiment period there were differences between various health ailments in different treatments. There were more incidences of diarrhea in T_3 as compared to other treatments. One animal died in T_3 group due to metabolic acidosis. So mortality in T_3 group was 16%. Shaver (2002) and Cook *et al* (2003) also reported that increased feeding competition due to overstocking may reduce intake and increase feeding rate, possibly increasing the risk for metabolic problems such as displaced abomasum and subacute ruminal acidosis.

4.8 Economics of kid production

The economics of kid production was calculated on the basis of following assumptions.

The cost of concentrate feed and roughages was calculated on the basis of current ingredient price given below

Ingredients	Price (Rs. per kg)
Maize	15.15
Soybean	35.00
De-oiled rice bran	12.50
Mineral Mixture	55.00
Common salt (NaCl)	9.00
Wheat bran	13.00
Green fodder	2.00

Cost of feed:

Component	Price (Rs per quintal)
Concentrate	1682.00

Assumptions:

1. The kids are farm born so their purchase price was assumed zero.
2. Land is owned and cost of construction of shed

   Closed area - Rs 400/ ft^2

   Open area - Rs 200/ ft^2

   Assuming life span of building 20 years. Rate of depreciation will be 5% per year.
3. The cost of treatment was calculated about Rs. 5.00 per day irrespective of the problem which includes only medicine charges.
4. Number of treatment days = Disease days of animals during experimental period
5. Since the current chevon price is Rs 380.00 per kg, so, sale price of kids at 6 month of age was fixed @Rs. 190.00 per kg live weight basis. These kids may receive at least 10 % premium price due to excellent quality as per their tender age.
6. Cost of labour, electricity, water, veterinary doctor fee etc were adjusted from premium price for excellent meat quality

Table 4.11 clearly indicated that T_1 group has higher margin of returns over the input cost as compared to control group T_0 while lower space treatments have low margin of returns. Wolter *et al* (2000) also reported that the pigs with group sizes of 20 were the most profitable approach to house rather than 100 animals. This result was largely due to the reduction in growth rate observed during the nursery period for the larger groups.

Table 4.11: Economics of production under various treatments under stall-fed conditions

Particulars	Treatments			
	T_0	T_1	T_2	T_3
INPUT (Rs.)				
Cost of construction	480.00	540.00	420.00	360.00
Cost of concentrate	3651.24	3669.42	3569.53	3496.86
Cost of fodder	369.36	372.6	355.42	346.68
Cost of treatment	65.00	50.00	55.00	90.00
Total input cost	4565.60	4632.02	4399.95	4293.54
OUTPUT (Rs.)				
Sale price of live animal	5688.60	6623.40	5289.60	4617.00
INCOME (Rs.)				
Total income	1123.00	1991.38	889.65	323.46
Cost-Benefit Ratio	1:1.25	1 :1.43	1:1.20	1:1.07

Table 4.12: Performance parameters under various treatments

Performance parameters	T_0	T_1	T_2	T_3
Concentrate (g/day)	402.26 ±7.58	404.06 ±7.49	393.72 ±7.54	385.43 ±8.16
Fodder (g/day)	342.57 ±8.93	345.79 ±8.50	329.08 ±8.48	321.68 ±8.44
BWG (kg)/3month	4.99 ±0.62	5.81 ±0.58	4.64 ±1.15	4.05 ±1.02
ADG (g)	55.46 ±6.96	64.61 ±6.49	51.57 ±12.79	45.00 ±11.34
FCR	7.77	6.70	8.15	8.51
Cost : Benefit ratio	1:1.25	1 :1.43	1:1.20	1:1.07

NS= Non-significant (p<0.05)

CHAPTER – V

SUMMARY

In intensive goat production comfortable housing is a prime factor of management. Information on floor space requirement of goats in tropical climate is very scanty. Minimum space allowances for goat should not be set only on an economic basis, because such allocations could conflict with animal welfare requirements. Behavioral, endocrine and immune responses to differences in space allowances seem to be a means of evaluating animal welfare, and the data could be used as a basis for necessary legislation.

Therefore the experiment was conducted at Goat Research Farm, Department of Livestock Production Management, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana to get specific information about the influence of different floor space allowance on the performance of Beetal kids under stall-fed conditions. The experiment was conducted from July to September 2014 on 24 kids of 3 months of age. The various observations recorded were on ambient temperature, relative humidity, feed and fodder intake, body weight, average daily gain, FCR, body measurement, behavior, faecal parasitic load and cost of input and value of output. All kids were kept under uniform predetermined managemental conditions except the treatments.

The mean temperature of shed was higher and mean relative humidity was low as compared to macroclimate during study period. The maximum temperature recorded inside shed in July was 31.45 ^{0}C whereas maximum outside temperature was 34.16 ^{0}C in July 2014.

The concentrate feed intake was significantly higher in T_0 and T_1 in August than T_2 and T_3 and in September T_1 concentrate feed intake was higher than T_0, T_2 and T_3 groups. The fodder intake was significantly higher in T_1 and T_0 than T_2 and T_3 groups in moth of August. No significant difference was observed for total dry matter intake, irrespective of the different groups.

During the 3 month study period total gain in body weight under different space allowances was 5.81 kg in T_1, 4.99 kg in T_0, 4.64 kg in T_2 and 4.05 kg in T_3. Also overall ADG in T_1 is 16.44 % higher than control while in T_2 and T_3 it was

7.01% and 18.86% lower respectively than control. The FCR was better T_1 group as compared to rest of the treatments. FCR for T_1, T_0, T_2, and T_3 was 6.70, 7.70, 8.15, and 8.51 respectively. There was no significant difference in performance parameters (Body weight, ADG, FCR), although they were better in higher space allowance group (T_1)

There was no statistical difference in Morpho-metric measurements between treatment groups. Behavior was significantly affected under different floor space allowances. Moving, resting, exploration was significantly higher in T_1 group as compared to others group while eating standing and negative social interactions were statistically significant in lower space allowance i.e. T_3. While the differences in stereotype, positive social interaction, urination and defecation was non-significant ($P<0.05$).

Coccidial load in T_3 group was significantly higher as compared to T_1 group in August month. Economic analysis revealed more cost: benefit ratio in higher space allowance (T_1) by maximizing throughput without compromising feed efficiency or increasing mortality as compared to lower space allowance (T_3)

From the above study following conclusions were drawn:

1. The total DMI was not significantly affected under different treatments
2. Reduction in ADG at lower space allowance (T_2 and T_3 group) was not due to feed intake but due to reduced feed efficiency as compared to higher space allowance (T_0 and T_1 group)
3. The performance parameters (body weight gain, average daily gain and feed conversion ratio) were better in more floor space allowance (T_0 and T_1 group) as compared to smaller space allowance.
4. Body measurements were not affected significantly under different treatments
5. Behavioral differences suggest that reducing floor space of kids to 0.6 m^2 has negative impact on welfare of kids
6. Higher floor space tend to have lower parasitic load than lower floor space
7. Economic analysis indicated that performance advantage of low stocking density compensate for increase in housing cost and there was maximum income in T_1 group due to better growth of kids.

RECOMMENDATION

Though BIS recommend 0.8 m^2 per kid (3-6 month) but Beetal breed of goat is comparatively larger in size than the other goat breeds available in India. So, it is recommended that optimum floor space requirement for Beetal kids ageing 3-6 months should be 0.9 m^2 per kid under stall-fed conditions in summer season. Further studies on floor space allowances should be undertaken with different group sizes in different seasons.

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EDUCATIONAL QUALIFICATION

Bachelor’s Degree	:	B.V.Sc. & A. H.
University	:	CSKHPKV, Palampur (H.P.)
Year of award	:	2013
OCPA	:	6.93 /10.00
Master’s Degree	:	M.V.Sc.
OCPA	:	8.38/10.00
Awards/Distinctions/ Fellowships/Scholarship	**:**	University Merit Scholarship from 2014-2015 in M.V.Sc.