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Effects of Selected Routine Husbandry Practices on Growth Rate of Weaned Small East African Goats

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Abstract: This study was conducted to determine the effects of overnight housing, helminthes control, supplementation and their combinations on average weight gain of weaned Small East African Goats (SEAG) in the semi-arid southeastern rangelands of Kenya. The study also evaluated the economic viability of these goat husbandry practices. About 40 weaned Small East African Goats of similar age (7±1 months) and weights (21±3 kg) were randomly assigned to the following eight treatments: housing (T_h); helminthes control (T_d); supplementation (T_s); housing+supplementation (T_{hs}); housing+helminthes control (T_{hd}); supplementation+ helminthes control (T_{sd}); housing+supplementation+helminthes control (T_{hsd}) and control (T_c-traditional husbandry). All the animals were weighed every week and weight gains calculated as the difference between the current and previous weight. The experiment lasted for 18 weeks. All treatment groups consistently exhibited higher average weekly weight gains than the control over the entire trial period. However, the enhanced weight gains were not statistically significant ($p<0.05$) up to the end of 3rd week. On the 4th week, however all treatment groups except housing, registered significantly ($p<0.05$) higher weight gains than the control. Overall a combination of all the three treatments (T_{hsd}) had the highest impact on the goats weight gain (6.95 kg) followed by T_{sd} (6.65 kg). The cost-benefit analysis indicated that the most cost-effective treatment was helminthes control with a Benefit-Cost Ratio (BCR) of 9.45. Supplementation and supplementation combined with helminthes control with 2.35 and 2.75 RBCs, respectively were also cost-effective. The results of this study support the conclusion that housing; control of internal parasites; enhancement of nutrition or a combination of any of these practices has the potential of substantially improving the weight gain rate of weaned Small East African Goats which would translate into increased off-take and ultimately, income.

Key words: Supplementation, growth rates, weight gains, small, East African goats, Kenya

INTRODUCTION

Sheep and goats, estimated at 1.1 and 0.83 billion heads, respectively are the second and fourth largest livestock groups in the world (FAO, 2007). According to the same Food and Agricultural Organization report, sheep production is more important in developed countries (40%) than goat production (5%) and goat production more important in developing countries (95%) than developed countries (5%). The report further points out that the overall production of these two species of livestock has expanded substantially in developing countries, particularly in the arid and semi-arid regions of Africa but decreased or stagnated in developed countries. Of the two kinds of livestock, the goat is probably more popular and its products (meat and milk) the most widely consumed. With >100 million heads (FAO, 2007), the Eastern Africa region has the highest concentration of goats in Africa. Kenya has approximately 7.7 million goats compared to 5.0 million sheep and 9.0 million cattle. About half the goats are found on smallholder farms in pastoral areas and in the highlands (Sibanda *et al*., 1999). During the last 15-20 years, countries like Kenya, Nigeria, Rwanda and Ghana have witnessed unprecedented increase in consumption of small ruminant meat particularly in the urban centres and hence the need for increased production and productivity of these animals. Despite the significant economic contributions that the small ruminants make to the world economies and particularly those of the African nations, their productivity per animal unit or unit area remains critically low. This is largely attributed to poor nutrition due to poor pastures, diseases, parasites and environmental factors such as climate. For instance, gastrointestinal nematodes, especially *Haemonchus conturtus*, have consistently been recognized as major constraints to small ruminant

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production in the tropics. Although, goats like other animals have an innate capacity to cope with adverse climatic conditions (excessive heat, cold, humidity and wind), appropriate efforts to minimize these stresses through for instance, sheltering have nearly always resulted in improved health and productivity in terms of milk and meat production. However, these improvements tend to vary in time, space and livestock species. The objective of this study was therefore to evaluate the techno-economic feasibility of overnight sheltering, supplementation, helminthes control and combinations of these treatments on weight gains of weaned goats in the semi-arid hinterlands of southeastern Kenya.

MATERIALS AND METHODS

Study area: The study was conducted within the Kenya Agricultural Research Institute's Kiboko Station situated approximately 2.3°S and 37.8°E, 1000 m above sea level. The mean annual rainfall is 615 mm and of bimodal distribution. The short rains season is October-December and the long rains season is March-May. Mean monthly temperature range is 27-31°C.

Experimental animals, design and protocol: About 40 weaned Galla goats of similar age (7±1 months) and weights (21±3 kg) were randomly assigned to eight treatments in a completely randomized experimental design. The treatments were: housing (T_h); supplementation (T_s); helminthes control (T); supplementation+housing (T_{hs}); supplementation+ helminthes control (T_{sd}), housing+helminthes control (T_{hd}); housing+helminthes control+supplementation (T_{hsd}) and control (T_c).

The control treatment involved normal grazing and watering without any of the three husbandry practices. Supplementation involved providing the goats with 100 g of Acacia tortilis pods every morning before they were taken out for grazing. Helminthes control involved administration of one of the recommended commercial antihelmintic at the beginning of the experiment and at 3 month intervals thereafter.

Housing treatment entailed enclosing the animals at night in sheds whose sides were made of half corrugated iron sheets and half chain-link wire-mesh and corrugated iron sheet roof. The floor was bare ground. All the experimental animals were herded together during the day and received the same husbandry care. The study lasted 18 weeks. The experimental animals were weighted individually on Friday of every week. Weighing was done in the morning before the animals were fed or watered. The weekly weight gain per animal for each treatment group was calculated as the difference between the previous and the current week's weight.

Statistical analysis: To determine which treatment had a significant effect on the goat's performance, the data were subjected to analysis o f variance (ANOVA). Where the treatment had statistically significant effects, the Duncan's New Multiple Range Test (Steel and Torrie, 1980) at 5% level of significance was conducted to pick out the means which were different.

RESULTS AND DISCUSSION

Table 1 and Fig. 1 shows the average bi-weekly body weight gains of the weaner goats under the main treatments during the 18 week trial period. Overall, all the treatment groups exhibited higher average weight gains than the control. However, the improvement in performance in all treatments were not different ($p<0.05$) from the control group within the first 3 weeks. But from the 4th week onwards, all the treatment groups except housing, exhibited significantly ($p<0.05$) higher growth rates than the control treatment group.

Effects of supplementation (T_s): As anticipated, supplementation (T_s) significantly ($p<0.05$) improved the goats rate of weight gain. This was achieved during the 4th week and was sustained throughout the trial period. The positive response of the goats to simple supplementation supported findings of Knox and Steel (1996) where weaned lambs and kids supplemented with urea molasses blocks performed better than the unsupplemented ones.

Supplementation tends to rectify unbalanced nutritional situations (Devendra and Burns, 1983) of animals through supply of nutrients that are missing in their diets under a given set of circumstances. It is a common practice among livestock producers when the available forage fails to meet the nutritional requirements of a particular animal. With nitrogen-deficient diets, provision of additional nitrogen can have a dramatic improvement on the digestibility of the feed and ultimately the productivity of the animal. The superior growth rates exhibited by the supplemented animals in this study can be attributed to the additional crude protein (15%) supplied by the Acacia tortilis pods. The pods had approximately twice as much CP as the available grass at that time of the year.

Effects of helminthes control (T_d): Helminthes control (T_d) also resulted in significant ($p<0.05$) increase in the rate at which the goats gained weight. However, the increase in rate of weight gain only attained statistical significance on the 6th week (Table 1). The positive impacts of helminthes control on the goats growth rate

Table 1: Mean weekly live weight gains (kg) of weaned galla goats housed, supplemented or dewormed

	Weeks								
Treatments	2	4	6	8	10	12	14	16	18
T_c	0.55	0.70^{b}	1.15^{a}	1.50^{a}	1.55^{a}	1.70^{a}	1.95^{b}	3.30^{b}	4.15^{b*}
T_h	0.80	1.20^{ab}	1.85^{ab}	3.10^{ab}	2.00^{ab}	2.45^{ab}	4.00^{ab}	4.35^{ab}	4.90^{ab}
T_s	1.05	1.45^{a}	2.90^{bc}	2.70^{bc}	2.80^{b}	3.40^{b}	4.10^{a}	5.35^{a}	6.00^{a}
T_d	0.90	1.40^{ab}	2.15^{bc}	2.65^{bc}	2.80^{b}	3.50^{b}	4.20^{a}	5.25^{a}	5.45^{a}

*Treatment means in the same column with different superscript are significantly different (p<0.05)

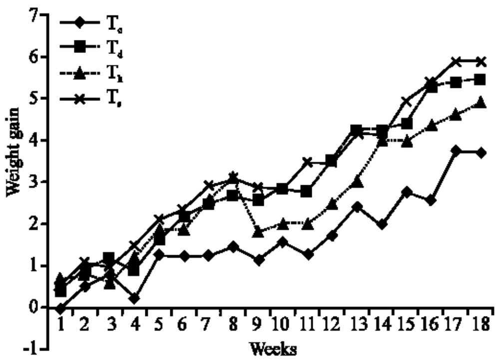

Fig. 1: Mean weekly body weight gain of weaned kids under housing, supplementation and helminthes control

reported in this study were consistent with those of Faizal *et al.* (2002) who reported that dewormed goats had significantly higher average weight gain rates than the control ones. In a separate study, Osaer *et al.* (2000) concluded that in spite of the continuous risk of infections and other environmental stresses, regular helminthes control improved the growth rate and general health of indigenous sheep and goats. Parasitic infestation ranks high among the factors that constrain livestock production especially in the tropics. Biologically, they restrict the productivity of animals through reduced efficiency of nutrient utilization reduced growth rate and ultimately death of animals that occurs at very severe infestation levels (Shavulimo, 1989). It is apparent that animals have innate mechanisms which enable them to withstand a range of worm infestation level. However, this is only up to a certain point, beyond which the negative effects of the worm load begin to show and intervention becomes necessary. Therefore, knowledge of the epidemiology and immunology of helminths is essential for their effective management (Provost, 1989).

Effects of housing (Th): The effect of overnight housing (T_h) of the weaner goats was not significantly different (p<0.05) from that of the control group (unhoused). These findings were consistent with those of Xiccato *et al.* (2002) where the effects of housing on veal calf growth, carcass and meat quality were found to be less pronounced than those not housed. Poor housing or the absence of it altogether exposes animals to adverse weather conditions which forces animals to burn extra energy to maintain normal body temperatures and physiological processes. Exposure to these factors may also predispose the animals to diseases such as pasteurella pneumonia (ILCA, 1988). Furthermore, housing facilitates earlier detection of sick animals and faster intervention (Charring *et al.*, 1992). During the study period, the weather was warm and dry which could account for the small difference between inside and outside the house at night and hence the similarity of performance between the two treatment groups.

Effects of treatment combinations: Table 2 and Fig. 2 shows the average weekly body weight gains of the weaner goats when subjected to various combinations of the above treatments. Overall all the treatment combinations exhibited higher average weight gains than the control. However, like the single treatments none of the treatment combinations had a statistically significant (p<0.05) effect on weight gain within the first 3 weeks.

Effects of supplementation and housing (T_{hs}): The combination of housing and supplementation (T_{hs}) treatments significantly (p<0.05) improved the rate of weight gain of the goats. This was apparent at the end of the 6th week and remained high throughout the trial period. Since housing alone did not significantly increase the growth rate of the goats, the improved weight gain rates when housing was combined with supplementation can therefore largely be attributed to the latter. It is also worthy highlighting the fact that weather conditions throughout the trial period were within the normal range which again might largely explain why housing did not have substantial effect on the performance of the goats. Poor plane of nutrition is known to be a major limiting factor in animal production and its minimization hence, has the potential of markedly improving the situation. The degree of response to changes in the nutritional environment of any animal varies with the breed of the

Table 2: Mean weekly live weight gains of weaner goats under combinations of housing, supplementation and helminthes control treatments for 18 weeks

	Weeks								
Treatments	2	4	6	8	10	12	14	16	18
T_c	0.55	0.70	1.15[a]	1.50[aa]	1.55[a]	1.70[a]	1.95[b]	3.30[b]	4.15[b]
T_{hs}	0.60	1.00	1.80[b]	3.25[b]	2.95[b]	3.60[b]	4.30[a]	5.75[a]	5.95[a]
T_{hd}	0.85	1.30	2.10[b]	2.95[b]	2.75[b]	3.80[b]	4.00[a]	5.50[a]	5.95[a]
T_{sd}	0.70	1.15	2.15[b]	3.15[b]	3.50[b]	4.20[b]	4.75[a]	6.00[a]	6.65[a]
T_{hsd}	0.85	1.40	2.85[b]	3.55[b]	3.85[b]	4.85[b]	5.40[a]	6.25[a]	6.95[a]

[a]Treatment means in the same column with different superscript are significantly different (p<0.05)

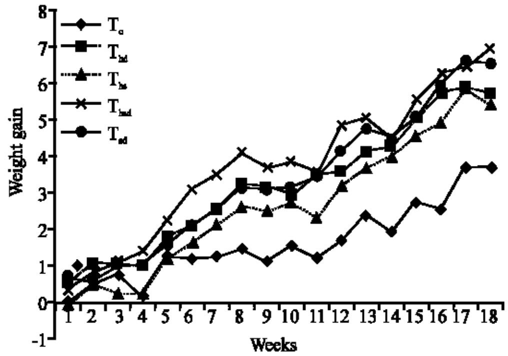

Fig. 2: Mean weekly body weight gain of weaned kids under combined treatments

animal (Devendra and Burns, 1983) and fluctuations of other parameters within the immediate vicinity of the immediate vicinity of the animal. For instance, changes in temperatures, humidity, sunshine and wind velocity may increase or decrease nutrient needs (NRC, 1981).

Effects of helminthes control and housing (T_{hd}): As anticipated, the housing x helminthes control (T_{hd}) treatment combination (Table 2) significantly (p<0.05) improved performance of the goats. The improved performance attained statistical significance (p<0.05) during the 6th week. The enhanced performance was largely attributed to the control of helminths since housing per sec had shown marginal effect on the growth rate.

Effects of supplementation and helminthes control (T_{sd}): The combined supplementation and helminthes control (T_{sd}) treatment significantly (p<0.05) boosted the growth rate of the goats. The treatment had the second highest improvement in weight gain of the goats. While the results suggest a strong interaction between supplementation (plane of nutrition) and helminthosis the effect was not statistically significant. That there exists an interaction between the nutritional status of an animal and its endo-parasite load is indisputable. Literature review on this subject area indicates that the interaction of the two factors can manifest itself in either of the following ways: it can increase the ability of the host animal to cope with the adverse consequences of parasitism (resilience); it can improve the ability of the host animal to contain and eventually overcome parasitism (resistance) by limiting the establishment, growth rate, fecundity or persistence of the parasite or it can directly affect the parasite population through the intake of antiparasitic compounds. Coop and Kyriazakis (1999) argued that the ability of an animal to withstand the stress of gastrointestinal parasites competes with other bodily functions when nutrient resources are scarce. Therefore, animals will invariably give priority in nutrient partitioning to the maintenance of body protein, since this guarantees the individual's survival in the short run. It is proposed that growth and reproduction which ensure the survival of the species in the long run are given the second-highest priority. This implies that functions such as immunity to or ability to withstand gastrointestinal parasites are accorded relatively low priority in the allocation of scarce nutrients. According to Wallace *et al.* (1998), supplementing the diets of animals heavily infested with parasites can only marginally improve their growth rates.

Effects of housing, supplementation and helminthes control (T_{hsd}): The combination of all three treatments depicted the highest overall performance of the goats throughout the trial period. Although the interaction effects again were not significant, it was apparent that all three treatments were beneficial to the goats which accounted for the superior weight gain rates that were observed. In practice, parasites reduce an animal's appetite, leading to decreased feed (nutrient) intake and ultimately a reduced growth rate. Therefore, with effective control of parasites should reverse this trend with increased feed intake translating into higher growth rates as was observed in this study. The use of low-cost supplements has been shown to be effective in enhancing an animal's ability to utilize the basal diet and boost its ability to withstand parasite infestation.

Wallace *et al.* (1998) found that infested animals on supplementary diet had similar performance to those that were not infested. They further observed that infested animals on a similar basal diet had substantially lower feed conversion ratios than those that were not infested but on the same diet. They concluded that the differences in weight gain among the two groups of experimental animals reflected the differences in appetite and the diet quality. Knox and Steel (1996) concluded that in situations where nutritional deficiencies are likely to exacerbate the detrimental effects of parasitic infestation, low cost non-protein nitrogen supplements can enhance the efficiency of feed utilization and assist animals to withstand fairly high worm infestation levels. Although housing alone did not have significant effect on weight gain in this study, it is important to note that its impact depends on the prevailing weather conditions. Care should therefore be taken to ensure that gains from any one of the interventions (housing, supplementation and/or helminthes control) are not lost through compromising of any one of the other factors.

Cost-benefit analysis of the treatments: While it is important to assess the productivity improvement of any technology, the more important question to the farmer or livestock producer is not whether it works but rather whether it is economical. The more it pays to make certain changes, the more attractive and practical to the producer. The cost-benefit analysis helps to determine whether it pays. Supplements are fed to improve production efficiency and to meet production targets that are expected to optimize gross margins for the specific production in question. However, the marginal costs and benefits of the supplements depend largely on their effect on roughage intake. The economic advantage of using optimum amounts of feed depends on how much such feed affects intake and performance. A cost benefit analysis finds, quantifies and adds all the positive factors-the benefits. Then it identifies, quantifies and subtracts all the negative factors-the costs. The difference between the two indicates whether the planned action is worthwhile. Growth performance results showed that there were significant differences ($p<0.05$) between supplemented goats and those not supplemented. Similarly, there were significant differences ($p<0.05$) between the dewormed goats and those not dewormed. The total costs for supplementation and helminthes control were obtained by estimating the operating costs. The operating costs consisted of the costs of the variable inputs used. These costs included the expenses of antihelmintics and the supplements. The benefits were the incremental weight gains due to treatments. Market prices of inputs and meat products prevailing in the study area in 2004 were used. The decision criterion is that for the various treatments to be shown to be economically viable a Benefit-Cost Ratio (BCR) of one or more must be realized. Table 3 shows that with a BCR of 9.45, the most cost-effective treatment is helminthes control (T_d) followed by supplementation combined with helminthes control (T_{sd}), supplementation (T_s) and the housing, supplementation, housing and helminthes control (T_{hsd}) treatment combination. The combined housing and helminthes control (T_{hd}) treatment was proximal to the break-even operation situation. The rest of the treatments resulted in losses. As shown in Table 3, housing reduces the benefits when it is combined with the other treatments. This outcome is due to the high initial cost of the house. Farmers therefore should consider the cost of the materials they use to construct houses for their animals so that it does not reduce the profitability of the enterprise. Alternatively, the value of the products has to be high enough such that it can offset the costs incurred.

Table 3: Cost-benefit analysis of the effect of the different treatments on weight gain by weaner goats

Trt	Weight increase	Expected benefits[1]	Expected cost[1]	BCR
T_c	4.15	-	-	-
T_h	4.90	6873	15235	0.45
T_s	6.00	16953	7216	2.35
T_{hs}	5.95	16495	22451	0.73
T_d	5.45	11913	1260	9.45
T_{hd}	5.95	16495	16495	1.00
T_{sd}	6.65	22910	8477	2.70
T_{hsd}	6.95	25659	23712	1.08

Trt = -treatment; [1]Benefits and costs are spread over 20 years

CONCLUSION

The results of the study clearly demonstrated that weather, nutrition and/or parasites are important components of a goat's environment. The performance of these animals can be substantially increased if farmers paid some attention to these elements. Specifically, the results showed that supplementation and/or helminthes control of young (weaned) goats can significantly increase their growth rates. Protection of the goats from the vagaries of weather also proved to be beneficial, although the improvement was not dramatic. The results demonstrated complementarities among the three husbandry practices. The complementary roles of supplementation and endoparasite in goats (and other kinds and classes of livestock as well) has other benefits, though rather implicit, especially in the semi-arid environments where scarcity of feeds is the order of the day. For instance where the farmer is not able to supplement the goats, it will still be possible to achieve better growth rates if they are able to maintain low levels of endoparasite infestations. The economic benefits accruing from any husbandry practice should be used to guide the decision making process. Cost-benefit analysis of the treatments indicated that helminthes control was the most cost-effective way of improving the growth rate of the goats with the other treatments enhancing that benefit.

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