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Effects of feeding energy and protein levels during the transition period on production performance of Arsi cows and Birth weight of their crossbred calves at Adami Tulu Agricultural Research Center

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Abstract

The effect of feeding different energy and protein levels during the transition period on DMI, production performance of Indigenous Arsi cows in early lactations, birth weight of their calves and profitability were evaluated at Adami Tulu Agricultural Research Center. Twenty-four Indigenous Arsi breed cows with an initial body weight of 176.8 ± 22.26 kg (mean ± SD) were used for the experiment. The animals were selected from the nucleus herd in the center and assigned randomly to one of the four dietary treatments in a Randomized Complete Block Design. The animals were fed on their respective diet for 60 days. The dietary rations were formulated based NRC, 2001 recommendation for dairy cows. The dietary treatments were: T1= 100 % NRC requirement of net energy and 100% NRC requirement of crude protein, T2 =100 % NRC requirement of net energy and 80 % NRC requirement of crude protein, T3= 100 % NRC requirement of crude protein and 80% NRC requirement of net energy and T4 = 80% NRC requirement of net energy and 80% NRC requirement of crude protein. Feed intake and body weight were measured and recorded daily and every 15 days, respectively. Birth weights of the calves were measured immediately after calving. The result indicated no significant differences (P > 0.05) among the treatments in average daily and final BW gains and in FCE of the experimental animals. Similarly, there was no significant difference among treatments in daily feed intake of the experimental animals both before and after calving. On the other hand, a significant difference was observed among the treatments in birth weight of the calves. Calves born from cows fed on the experimental diets of treatment three and two were the heaviest. The result of this study indicated that the highest net return (5117 ETB/cow) was obtained from experimental animals in treatment four followed by those in treatments two and three. The total variable cost increased as the level of protein increased across the treatments. With regard to improved birth weight of calves, treatments two and three are recommended. From the partial budget analysis, treatment four resulted in the highest net return and hence advised for additional interventions. In general, all the supplements utilized in this study produced good average daily gains and positive net returns indicating that they can be used to supplement various energy and protein amounts during transition period.

Key words: *Arsi cows, Transition period, Weight gain, Birth weight*

Introduction

In Ethiopia, dairy production mainly depends on local cattle breeds and diets of inadequate quality and quantity under low input and output production system (FAO 2018). In rural areas where majority (98%) of farmers keep local cattle, livestock production system is totally dependent on a variety of basal feed resources which vary both in quantity and quality. Across all production systems, 99% of the total milk production is contributed by cattle. The majority of cows kept are local breeds, with a limited number of farmers keeping few crossbred grade dairy animals (GebreWold *et al*., 2000). The milk production potential of local breeds is very low due to multifaceted problems. Approximately 3.2 billion liters of milk is produced from 10 million milking cows, an average of 1.54 liters of milk per cow per day over a lactation period of 180 days. Ignoring these local cattle breed or overlooking their feeding strategies and only focusing on crossbred or pure exotic breeds exposed local breeds to many production diseases and reduced their production and productivity.

The current breed improvement strategies through different means such as selection, new breed development and systematic cross breeding targeted local cattle breeds as foundation stocks. New Breed development at some places of the country is a good start to improve the milk production potential of the country, subsequently to fill the huge gap between milk demand and supply which is 18 billion liters per year) (CSA, 2017). However, without giving much attention to their feeding strategies in the way that the animals can express their genetic potential, it hampers and prolongs the number of years needed to develop this new breed. Moreover, lack of proper nutrition leads to increased service per conceptions, low conception rate, long age at first calving, long calving interval, and poor mothering ability. Therefore, giving due attention to local breeds especially during the transition period is crucial during breed improvement or development program.

The transition period is the time between 3 weeks before calving to 3 weeks after calving (Grummer 1995; Drackley, 1999). This is a key period in the lactation cycle during which the dairy cows under go different physiological, immunological and metabolic changes to shift from pregnancy state to lactation state (Annen et al. 2004, Drackley, 1999).

Although, the dry matter intake of the cows reduces by 30-40% during transition period, their demands for glucose and amino acids increases by 2.7 and 2 times, respectively after calving (Bell, 1995). As a result of this, dairy cows usually experience negative nutrient balance and metobolic disorder due to inability to meet the increased demands for nutrients for fetus, mammary gland development and for the subsuqenet onset of lactation (Grummer et al. et al., 2004; Mann et al., 2016). Previous research indicated that pre-partum feeding of high energy diet had a more positive energy balance, higher plasma glucose concentrations and insulin, lower concentrations of plasma free fatty acids compared with cows fed low energy diet (Rabelo et al., 2005).

Currently, the activity of new breed development using Indigenous Arsi cows as dam line and semen of Holsteins Friesian as sire line is being implemented at Adami Tulu Agricultural Research Center to overcome the problem of low genetic potential of the local cattle breed. Participant farmers involved in this breed development program

also use Arsi-cows as dam line and F1 crossbred male bulls are being distributed for them as sire line to produce different exotic levels. However, in line with this work, there is no promising feeding package or technology that support the program both at on-station and at on farm levels. Proper feeding of local cows during the transition period is also not well experienced and is overlooked to improve the milk production potential of the cows.

Hence, generation or adaption of feeding strategies targeting local genotypes and aligned with what the farmers need s and with the current new breed development program is necessary to come up with full package for the end users. Therefore, this study was designed to evaluate the effect of feeding different energy and protein levels during the transition period on DMI and production performance of Arsi cows in early lactations, on birth weight of their newly born cross bred calves and the profitability of using such rations.

Hypothesis

Feeding high energy and protein diets to Arsi-cows during the transition periods improves the dry matter intake, milk production of cows and birth weight of their cross bred calves.

Materials and methods

Study area

The study was conducted at Adami Tulu Agricultural Research Center which is located at 167 km south of Addis Ababa at latitudes of 7^0 9' N and $38^0$7'E longitude. The area is situated at 1500 meters above sea level and the soil type of the area is fine, sandy loam with sand, and clay in the proportion of 34:48:18, respectively. The area gets an average rainfall of 760 mm annually. The minimum and maximum temperatures are 12.6 and 27^0c, respectively (ATARC, 2003).

Experimental animals, design, and treatments

Twenty-four Indigenous Arsi breed cows with an initial body weight of 176.8 ± 22.26 kg (mean ± SD) were used in the experiment. The animals were selected from the nucleus herd in Adami Tulu Agricultural Research Center. They were blocked into four blocks of six animals based on initial live weight and were randomly assigned to one of the prepared treatment rations. The experiment was conducted for 60 days.

Formulation of the dietary rations

Eight dietary total mixed rations (four for close up cows and four for fresh cows) containing different dietary energy and protein levels were formulated from different locally available feed resources/ingredients such as Rhodes grass hay, corn silage, wheat bran, brewers grains, Noug cake, molasses, cotton seed cake and salt.

The main reason of formulating total mixed rations from many locally produced feed ingredients instead of using single or a combination of 2 to 3 feedstuff is to generate promising feeding technologies that help small holder farmers in a sustainable way as feed availability and its price are the most critical issues for almost all the dairy producers.

The dietary energy and protein levels both for pre and postpartum cows were formulated according to the National Research Council (NRC, 2001) recommendations for net energy (NE_L) and CP percentage for the lactating dairy cows based on dry matter intake, body weight and cows' production performance. The total mixed ration was formulated and fed to dairy cows to meet 100% NRC, or 80% NRC requirements of net energy lactation (NE_L) and protein for dairy cows during the transition period. The required dietary energy and protein levels in the total mixed rations were formulated using feed WIN or other software from available feedstuff according to (NRC, 2001).

Dietary treatment

T1= 100 % NRC requirement of net energy lactation and 100% NRC requirement of crude protein

T2 =100 % NRC requirement of net energy lactation and 80 % NRC requirement of crude protein

T3= 100 % NRC requirement of crude protein and 80% NRC requirement of net energy lactation

T4 = 80% NRC requirement of net energy lactation and 80% NRC requirement of crude protein

The ration was formulated for both before and after calving based on their requirements. All experimental cows were fed on their respective dietary treatment ration individually starting from 30 days before calving up to calving date (0 day). Soon after calving, on day 1, experimental cows were fed on their respective dietary rations fed during the close-up period, but the amount of net energy for lactation and CP percentage of the dietary rations were changed and formulated based on NRC (2001) recommendation for the dairy cows in early lactation. Feeding the experimental cows continued up to 30 days after calving. Based on their requirement, the amount needed per day was provided twice per day, one in the morning at 8:00AM after the refusal was collected, and the remaining amount in the afternoon at 2:00 PM. Water was freely available for all experimental cows throughout the study period.

Laboratory analysis of feed samples

During the whole experimental period, the amount of feeds offered and feed refused were recorded each morning. Dry matter intake of the cows was determined by measuring the difference between the amount of feed offered and refused on a dry matter basis. Representative feed samples of the total mixed rations offered and refused from each treatment were analyzed for dry matter content by oven-drying at 60°C to a constant weight. The dried samples were ground through a 1-mm screen before analysis. To remove all moisture contents, feed samples were further dried at 105°C for 2 h to determine the absolute dry matter. Chemical composition of the feeds was analyzed and expressed on the basis of the final absolute dry matter. Crude protein CP (N × 6.25) contents of the feed samples were determined using the macro-Kjeldahl nitrogen test (AOAC, 2000; method 976.05). The contents of neutral detergent fiber and acid detergent fiber were determined using the Van Soest et al. (1991) procedure using heat-stable amylase at the Holeta agricultural research center. Ash contents of the total mixed

rations were determined by incineration at 550°C overnight, and the OM content calculated (AOAC, 2000; method 942.05).

Feed intake and conversion efficiency

Animals were fed the experimental diets for 60 days in individual pens, and daily feed intake was recorded. Daily feed intake of the individual animals was calculated as follows:

$$Daily\ \ Feed\ intake\ (g) = amount\ of\ feed\ offered\ (g) - amount\ of\ feed\ refused\ (g)$$

Feed conversion efficiency was calculated using the formula suggested by Gülten *et al*. (2000):

$$Feed\ conversion\ efficiency = \frac{Average\ daily\ live\ weight\ gain\ (g)}{Average\ daily\ feed\ intake\ (g)}$$

Live weight change and daily gain

The live weight of each animal was taken at every 15 days interval in the morning before provision of feed and water. The live weight change was calculated as the difference between the final body weight and initial live weights. Average daily gain (ADG) was calculated as:

$$Avergage\ daily\ gain\ (\text{g}\ /\text{day}) = \frac{Final\ body\ weight(\text{g}) - Initial\ live\ weight\ (\text{g})}{number\ of\ feeding\ days}$$

Data management and statistical analysis

The collected data on body weight change, body condition score of the cows and calves birth weight and their growth performance were analyzed using SAS software (9.2 version) with repeated measures using the under-mentioned model. The collected data were analyzed as a Completely Randomized Design with repeated measures using PROC MIXED of SAS (version 9.2, SAS Institute Inc.,Cary, NC).

The Mixed statistical model used for analysis will be:

$$y_{ijkl} = \mu + E_i + P_j + EP_{ij} + A_{ijk} + T_l + TE_{il} + TP_{jl} + TEPT_{ijl} + \varepsilon_{ijkl}$$

where, y_{ijkl} is the dependent, continuous variable, μ is the overall mean; E_i is the fixed effect of energy; P_j is the fixed effect of protein; A_{ijk} is the random effect of the k'th cows in the ij'th combination of energy and protein; T_l is the fixed effect of time (day) of the experiment; the $TEPT_{ijl}$ is the interactions of time, energy and protein, and ε_{ijkl} is the residual error. Means were compared using LSD and statistical differences were declared significant at $P \leq 0.05$.

Partial budget analysis

Partial budget analysis was conducted based on the total variable's costs incurred during the study period. This includes feed, labour and medication costs. The prices of all feed ingredients used were obtained from the market price prevailing during the experimental period. Partial budget analysis was taken to determine the cost benefit (profitability) of different proportions of concentrate to supplement the feed of indigenous cows. At the end of the experiment, the selling price of each experimental cow was estimated by three experienced local dealers and the average of those three-estimation price was taken. The total returns (TR) were determined by calculating the difference between the estimated selling prices and the purchasing prices of the experimental heifers.

Net return (NR) was calculated as: $NR = TR - TVC$

Results and Discussions

Daily feed intake

The daily feed intake of cows fed on the experimental diets is presented in Figure 1 below. There is no significant difference among treatments in daily feed intake of the experimental animals both before and after calving.

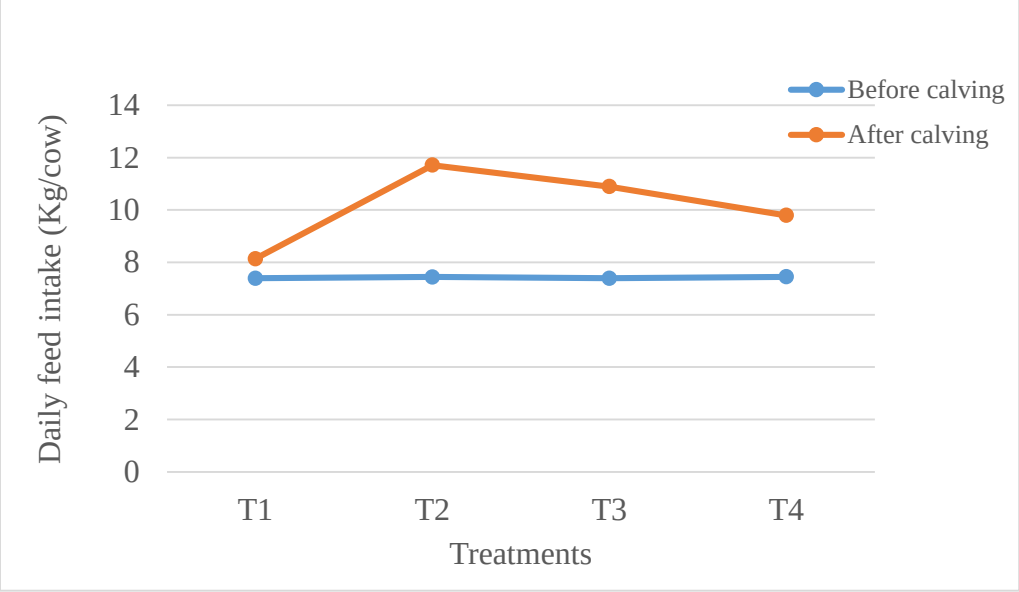


Figure 1. Trends of daily feed intake of the indigenous Arsi breed cows fed different levels of energy and protein during the transition period

Body weight gains

Mean values of initial and final body weight (BW), daily BW gain, and feed conversion efficiency (FCE) of the experimental animals is indicated in Table 1. The trends in Body weight changes and BW gains are also shown in Figures 2 and 3. The results indicated that there are no significant differences ($P > 0.05$) among treatments in average final BW, daily weight gains and FCE of the experimental animals. The

current result was in contrary with the findings of (Dann, H.D., *et al*, 2006) reported that cows fed on high energy diet at 150% NRC during the far-off period had higher body weight change, body condition score change, and insulin level in serum. The difference might be due to the difference in breed of experimental animals.

Table 1. Body weight changes of the indigenous cows fed on the 4 dietary treatments

Parameters	T1	T2	T3	T4	SEM
Average Initial body weight, kg	178.6	176.2	176.8	175.6	4.97
Average Final body weight, kg	184.8	205.2	187.2	186.2	6.1
Daily body weight gain, kg/day	3.08	3.4	3.08	3.1	0.09
FCE, kg DBWG/ kg DDMI	0.4	0.36	0.34	0.36	0.01

SEM = standard error of mean; FCE: feed conversion efficiency; DBWG: Daily body weight gain; DDMI: daily dry matter intake

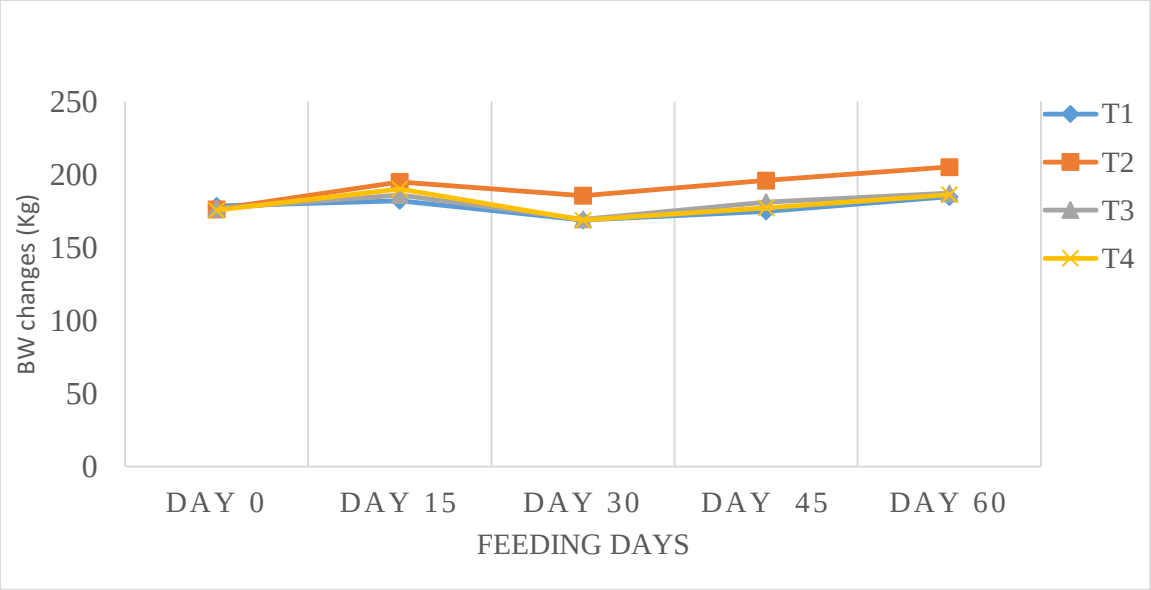


Figure 2. Trends in body weight changes of the experimental animals fed on the different dietary treatments during the transition period of 60 days.

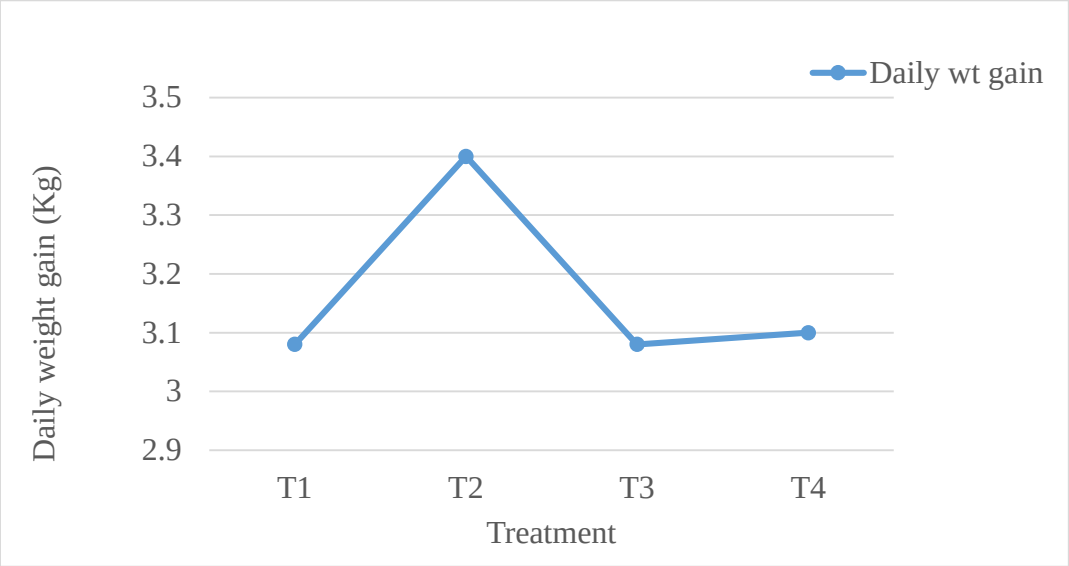


Figure 3. Trends in daily weight gain of the indigenous Arsi breed cows fed different dietary feeds during the transition period.

Birth weight of calves

The birth weight of the calves born from the experimental animals is presented in Table 2. The result revealed that there is a significant difference among treatments in birth weight of the calves born from cows fed on the different experimental diets. Calves born from animals in treatments three and two are heavier than calves born from animals in the other treatments. The current result is inline with findings of (Dann, H.D., *et al*, 2006) whose reported feeding different energy and protein diets had a significant effect on milk production, energy intake, cows and calves' health.

Table 2. Mean birth weight of calves born

Treatments	Mean ± SD	SEM
1	15.8^{ab}	1.2
2	17^{b}	0.7
3	17.8^{b}	0.87
4	13.6^{a}	0.9

$^{a, b,}$ Means with different superscripts in a column are significantly different ($P < 0.05$)

Partial budget analysis

The partial budget analysis of indigenous Arsi breed cows fed different levels of energy and protein during the transition period is presented in Table 4. A partial budget analysis was performed to evaluate the economic advantages of feeding cows with different levels of energy and protein levels during the transition period. The result of this study indicated that a higher net return (5117 ETB/cow) was obtained from experimental animals

in treatment four followed by those in treatment one and two. The result of the current study revealed that the total variable cost increased as the level of protein source feeds increased across the treatment.

Table 3. Partial budget analysis of indigenous Arsi breed cows fed different levels of energy and protein during the transition period

	Treatments			
Costs	**1**	**2**	**3**	**4**
Purchase price of animals (ETB/Cow) estimated	18,000	18,000	18,000	18,000
Total feed cost (ETB/Cow)	10,392.9	9,621.0	10,469.4	9,283.2
Medicine cost	225	225	225	225
Labor cost	375	375	375	375
Total variable cost (ETB/Cow)	10,992.9	10,221.0	11,069.4	9,883.2
Gross income (estimated sale price ETB/Cow)	33,000.0	33,000.0	33,000.0	33,000.0
Total return (ETB/Cow)	15,000	15,000	15,000	15,000
Net return (ETB/Cow)	4,007	4,779	3,931	5,117

Conclusions and Recommendations

During the transition phase, varying amounts of protein and energy supplements have an impact on body weight of the cows and the calves. With regard to improved birth weight of the calves treatments two (requiring 100% of the net energy lactation and 80% of the crude protein) and treatment three (requiring 100% of the crude protein and 80% of the net energy lactation) were advised.

Based on the partial budget analysis, the experimental diet of treatment four (80% NRC need of crude protein and 80% NRC requirement of net energy lactation) resulted in a higher net return and is recommended as an additional intervention.

In general, all the supplements utilized in this study produced good average daily gains and positive net returns indicating that all of them can be used to supplement various energy and protein amounts during transition period.

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