# Effect on Management of Feeding on Production Performance and Level of Stress of Tak Beef Cattle under Tropical Conditions in Thailand

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## Abstract

The objective of the present study was to investigate the raising of beef cattle using a low-as-possible cost feed method under hot wet conditions. Fifteen Tak beef (62.5 % Charolais and 37.5 % American Brahman) steers, age and live weight of approximately 1.5-2.0 years old and 250 kg respectively were placed randomly into three treatment groups. Feeding trial was conducted under typical hot humid conditions of Thailand (N 12 36.652, E 101 33.017), where the average THI was $80.18\pm1.75$ during September 2010 to March 2011. The feed consisted of fresh Pangola grass fed ad libitum and a commercial grade concentrate at 1.25, 1.75 and 2.25 (T1, T2 and T3) % body weight, respectively. The experiment was designed to test the animals' feeding performance with respect to the cost of production.

Due to the effect of heat increments under heat stress conditions, the results indicated that a feed mixture consisting of fresh Pangola grass with concentrate corresponding to 1.75% of the animal's body weight would provide an optimum average daily weight of gain (ADG) and subsequent return on investment under the hot wet conditions of central Thailand.

Keywords : Cost of production; Pangola: Stress; Tak beef breed

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**บทคัดย่อ**

การศึกษาเพื่อทดสอบการเลี้ยงโคเนื้อในสภาพแวดล้อมที่ร้อนชื้นโดยใช้วัตถุดิบราคาถูก การศึกษาครั้งนี้ใช้โคเนื้อเพศผู้ สายพันธุ์ตาก (62.5 % Charolais and 37.5 % American Brahman) อายุ 1.5-2.0 ปี จำนวน 15 ตัว โดยสุ่มให้อยู่ใน 3 กลุ่มการทดสอบการใช้อาหาร ทำการทดสอบที่ ศูนย์วิจัยทดสอบพันธุ์สัตว์นครสวรรค์ (เส้นรุ้ง 12 องศาเหนือ 36.652 ลิปดา, เส้นแวง 101 องศาตะวันออก 33.017 ลิปดา) ที่ดรรชนีความร้อนชื้นเฉลี่ย 80.18±1.75 ในช่วง การทดลอง ระหว่างเดือนกันยายน พ.ศ. 2553 ถึงเดือน มีนาคม พ.ศ. 2554 โดยใช้หญ้าแพงโกลาที่ผลิตที่ศูนย์วิจัยทดสอบพันธุ์สัตว์นครสวรรค์ ให้กินแบบเต็มที่และให้อาหารข้นที่ผลิตทางการค้าที่ระดับ 1.25, 1.75 และ 2.25 เปอร์เซ็นต์น้ำหนักตัวตามลำดับ  เนื่องจากอิทธิพลของความร้อนมีผลต่อการย่อยวัสดุอาหารในสภาพร้อนเครียดของโคเนื้อ ผลการทดลองพบว่า การให้อาหารข้นที่ 1.75% น้ำหนักตัวร่วมกับหญ้าแพงโกลา โคมีการเจริญเติบโตและผลตอบแทนต่อการลงทุนดีที่สุด

**คำสำคัญ:** ต้นทุนการผลิต, หญ้าแพงโกลา, ความร้อนเครียด, โคเนื้อพันธุ์ตาก

## Introduction

Since the introduction of European breeds (*Bos taurus*) into Thailand in 1950, there have been many crossbreeding programs between Bos taurus and Bos indicus cattle aimed at increasing the quality of beef as well as the heat tolerance ability of these cattle.

One such project is located in Thailand's northern province of Tak. The Department of Livestock Development, Ministry of Agriculture, Thailand (DLD) has developed a breed called the "Tak " named after the province where the Tak breeding station is located (N 12 36.652, E 101 33.017). The Tak breed has been developed from the American Brahman and Charolais breeds. American Brahman and Charolais females (50:50) are bred and these are then inseminated with American Brahman semen to produce a 75 % American Brahman and 25 % Charolais cross. After this, the crosses are inseminated with Charolaise semen, the resultant cross being 62.5 % Charolais: 37.5 per cent American Brahman. The breeding station distributes semen (62.5 % Charolais and 37.5 % American Brahman) which local farmers then use on their native Thai cows. (Anon, 2009).

Since Tak beef cattle have been bred to be employed in tropical conditions in Thailand, a dietary recommendation during times of heat stress has been to feed less forages and more concentrates in an attempt to lessen the heat load of digestion. Since roughage is more abundant and readily available at lower cost than concentrate, lowering the cost beef production is desirable.

Production of heat energy, accounting for 31% of total consumed energy (Coppock, 1985), is an obvious liability during hot weather. Digestion of forages produces significant heat in terms of fermentation in the cow, adding to the overall heat load. Given a choice, cows consumed less hay when subjected to heat stress (Johnson et al., 1963). Such behaviour should reduce metabolic heat production, given that lower heat production was reported in beef

heifers that were fed pelleted diets containing 75% concentrate compared with 75% alfalfa (Reynolds et al., 1991).

Since the crossbreed (Tak breed) has been developed with a view to its utilization in tropical regions, and since cost of production roughage is less than the cost to produce concentrate, the objective of the present study was to investigate the raising of beef cattle under heat stress conditions in Thailand using a low-as-possible cost of production.

**Materials and Methods**

The THI value was calculated using the formula (Armstrong, 1994) below:-

$$THI = T_{db} + 0.36(T_{dp}) + 41.2$$

Where: $T_{db}$ = Dry bulb temperature (°C)

$T_{dp}$ = Dew point temperature (°C)

**Location**

The experiment was carried out during September 2010 to March 2011, at Nakhon Sawan Animal Husbandry Research Station, DLD, Ministry of Agriculture, Thailand (N 15$^{O}$ 15' 36.8"; E 100$^{O}$ 38' 49.6").

Animals:

Fifteen Tak Beef Steers, each with initial age and live weight of approximately 1.5-2.0 years old and 250 kg respectively were used in this experiment. They were allocated randomly into 3 feeding treatments. Each treatment group consisted of 5 steers. Each animal was kept until it reached a final live weight of 450 kg.

Treatment:

Treatment 1 Concentrates at 1.25 % body weight + fresh Pangola grass (Control)

Treatment 2 Concentrates at 1.75 % body weight + fresh Pangola grass.

Treatment 3 Concentrates at 2.25 % body weight + fresh Pangola grass.

Parameters collected:-

1. Initial weight (kg)

2. Daily concentrate intake

3. Daily roughage (Pangola grass) intake.

4. Monthly individual live weight (kg) until reaching 450 kg.

5. Blood samples were drawn from the coccygeal vein at the end of the experimental period and. they were then transferred to a laboratory where they were spun with a centrifugal apparatus at 3000 rev/min to separate the serum, which was then stored at -20$^{O}$C for further analyses. The blood serum samples were analyzed for Cortisol at the Hormones Laboratory, Faculty of Medicine, Chulalongkon University using equipment from Siemens Medical Solutions Diagnostics, Erlangen, Germany.

**Statistical analysis:**

Analysis of covariance (Steel and Torrie, 1980) was used in the experiment and Duncan's new multiple range test (Duncan, 1955) was used to compare the mean value of parameters among the treatments when appropriate (SAS, 1999).

**Results and Discussion**

One steer from each of Treatments 1 and 3 was taken out of the experiment due to sickness, and analyses with missing values were used. The results of feed composition of Pangola (*Digitaria decumbens*) are as following:- 42.51% Moisture, 7.2% Crude Protein, 65.35% NDF, 38.31% ADF, 0.3% Ca and 0.15% P. While feed composition of the commercial concentrate are 13% Moisture, 12% crude Protein and 3.0% lipid. The concentrate used was a commercial cattle feed. The Pangola was grown at the station. The average monthly maximum THI (Figure 1) during the experimental period (80.18±1.75) was high and was in the threshold danger zone for beef cattle (Eigenburge et al., 2005; Koatdoke, 2006).
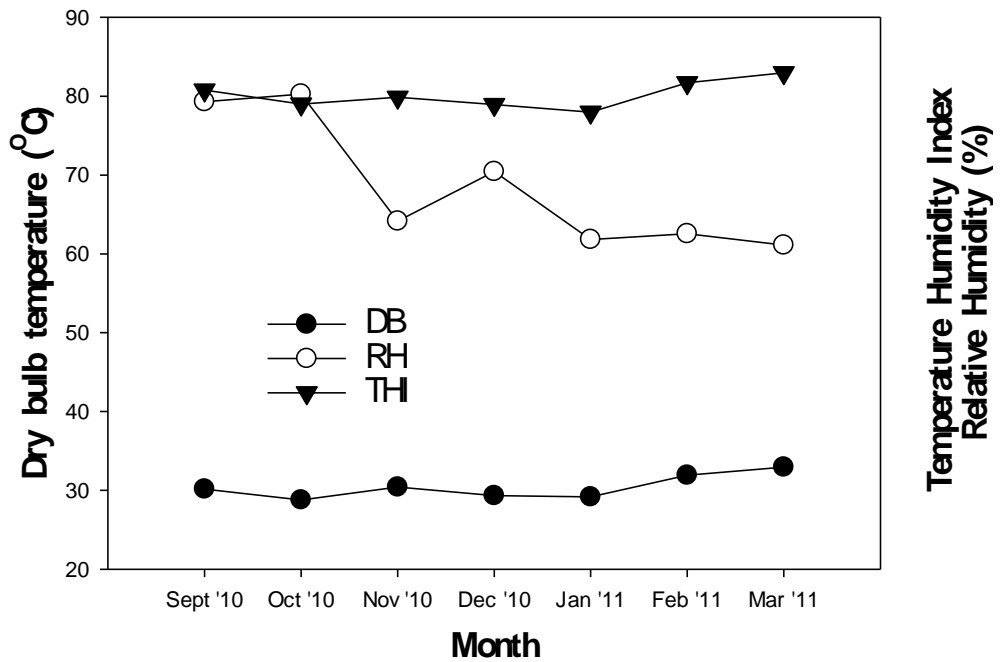


Figure 1    Shed ambient (DB) temperature, relative humidity (RH) and Temperature Humidity Index (THI) at Nakhon Sawan Province where the experiment was carried out.

**Table 1.** Mean±SD of DMI of roughage, concentrate (kg/head), total DMI , average daily rate of gain (ADG; g/hd/d), feed conversion ratio (FCR) and cortisol ($\mu$g/dl) of the steers in each treatment of the experiment.

| Traits | Treatment | | | P value |
|---|---|---|---|---|
| | T1 | T2 | T3 | |
| Roughage (kg/hd) | $665.32\pm47.86^{x}$ | $532.08\pm36.92^{y}$ | $390.96\pm46.15^{z}$ | 0.01 |
| Concentrate (kg/hd) | $780.05\pm12.73^{y}$ | $859.23\pm24.01^{y}$ | $1{,}099.31\pm101.37^{x}$ | 0.01 |
| TotDMI | $1445.37\pm45.54^{y}$ | $1391.31\pm46.79^{y}$ | $2847.09\pm39.60^{x}$ | 0.01 |
| ADG (g/d) | 839.38±81.06 | 1,035.06±101.26 | 1,009.47±181.25 | 0.09 |
| FCR | 7.87±0.21 | 7.69±0.84 | 8.12±0.55 | 0.61 |
| Cortisol (mg/dl) | $5.08\pm0.07^{a}$ | $3.70\pm0.98^{ab}$ | $2.35\pm0.11^{b}$ | 0.04 |

a, b, c - *Mean values* within same row with *different superscripts are significantly different* ($P < 0.05$).
x, y, z - *Mean values* within same row with *different superscripts are significantly different* ($P < 0.01$).
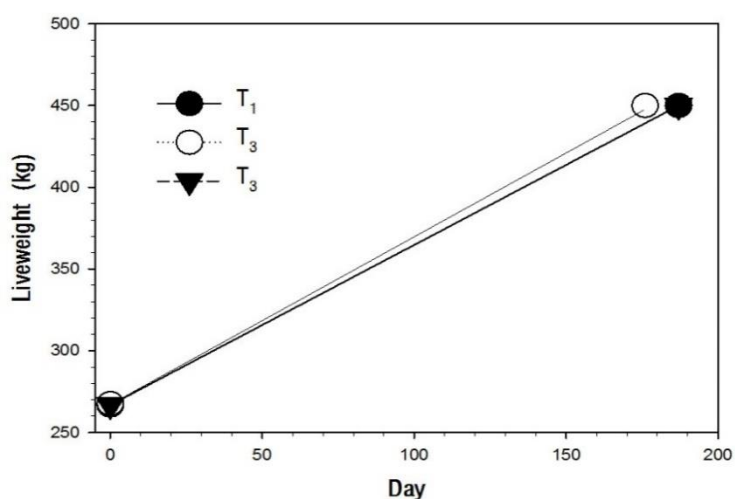


**Figure 2** Average liveweight (kg) of the steers in T1, T2 and T3 during the experimental period.

From Table 1, it can be seen that voluntary roughage intake of the steers in T1 (665.32±47.86 kg/hd) was significantly (P<0.01) higher than that of T2 (532.08±36.92 kg/hd), which in turn was significantly (P<0.01) higher than that of T3 (390.96±46.15 kg/hd).

Furthermore, the concentrate intake of the steers in both T1 (780.05±12.73 kg/hd) and T2 (859.23±24.01 kg/hd) was significantly lower (P<0.01) than that of T3 (1,099.31±101.37 kg/hd). There was no significant difference (P>0.05) between the concentrate intake of the steers in T1 and T2. Furthermore, total dry matter intake (TDMI; Table 1) of steers in T3 (2847.09±39.60 kg DM) was significantly (P<0.01) higher than that of T1 and T2 (1445.37±45.54 and 1391.31±46.79 kg DM, respectively).

The variation in DMI of the steers could be due to the fact that voluntary DMI of a ruminant depends on the quality and availability of roughage and the amount and type of supplement, environment and the animal itself (Forbes, 2007). In feeding both roughage and concentrate, a ruminant will prefer to eat the concentrate which has higher digestibility (Blaxter, and Wilson. 1962) first and then the roughage later in a feeding session.

Total heat production of cattle consists of the heat increment from digestive fermentation and nutrient metabolism, plus heat from basal metabolism and activity (Blaxter, 1962; Grant, 2015). Increasing the percentage of roughage in cattle diets results in a slight increase in heat production because of the increased heat increment due to feeding. Under hot environmental conditions, this increased heat production can result in reduced voluntary food intake. It is therefore advantageous to feed diets of low roughage content during hot weather (NRC, 1981).

The differences in DMI of concentrate in the present experiment may be partly due to the animals' efforts to compensate for energy reduction due reduced roughage intake under heat stress conditions (Johnson et al., 1963) and may also be partly due to the differing amount of concentrate offered to the respective treatment groups.

Adrenal corticoids, mainly cortisol, elicit physiological adjustment to enable animals to tolerate stress (Christison and Johnson, 1972). Blood cortisol levels increase significantly due to increase in ambient temperature in cattle (Aggarwal and Upadhyay, 2013).

The results (Table 1) of the cortisol of the steers in T1 (5.08±0.07 $\mu$g/dl) were statistically (P<0.05) higher than that of T3 (2.35±0.11 $\mu$g/dl). There were no statistical differences (P>0.05) between the cortisol level of the steers in T1 and T2 (3.70±0.98 $\mu$g/dl), nor between that of T2 and T3. The results clearly indicated that the steers in T1 were stressed by heat, followed in order by the steers in T2 and T3 respectively. This possibly related to the level of roughage intake i.e. heat increment.

The results (Table 1) showed a trend of difference in the average daily rate of gain (ADG) such that the ADG (Figure 2) of steers in Treatment 1 (T1; 839.38±81.06 g/d) tended (P<0.10) to be lower than that in both Treatment 2 (T2; 1,035.06±101.26 g/d) and Treatment 3 (T3; 1,009.47±181.25 g/d). The ADG of T2 did not differ (P>0.10) to that of T3.

**Sudarman and Ito** (2000) showed that in sheep, a high roughage diet induced a greater heat load on the ruminant than a low roughage diet when given at high ambient temperature, with effects being more pronounced at high intake levels. In the T1 group, where the steers received more roughage than the other two treatments and were under a high THI environment, these cattle exhibited the lowest ADG as a result of receiving high heat load as indicated by having a significantly (P<0.05) higher level of cortisol (Table 1) than T2. Cattle under heat stress tend to depress their feed consumption (Johnson, 1987; Adin et al., 2008), hence lowering ADG.

Feeding concentrate at higher levels did not increase ADG , and this could be due to the feeding concentrates' high starch levels i.e. feeding high starch diets to cattle tends to cause subclinical rumen acidosis (Enemark and Jørgensen, 2001). Beef cattle exposed to prolonged heat stress tend to have rumen acidosis (Huntington, 1988; Beatty et al., 2006), which leads to decreased ADG (Wheeler, 1980; Owens et al., 1998).

In beef production, the cost of feed contributes to about 70% of the cost of production (Loy and Tait 2011). In contrast, the cost of roughage production is much lower than the cost of concentrate production. In the present experiment where the animals were fed with different levels of roughage and concentrate under hot wet conditions, the results of cost of feeding per gain were not significantly different (P>0.05). However, after taking management costs into consideration, the result (Table 2) showed that Total cost (TC) of T3 (11,996.60±964.62 baht/hd) was significantly (P<0.05) higher than that of T2 (10,819.54±301.34 baht/hd) while TC of T1 was not significantly different (P>0.05) from T3 and T2. This could be due to the cost of concentrate used in T3 (8,414.35±658.36 baht/hd) being significantly (P<0.01) higher than that of T2 and T1 (6,666.66±153.65 and 6,078.63±102.38 baht/hd, respectively).

**Table 2**. Mean±SD of average days of experiment (d), cost per gain (baht/kg), cost of roughage (fresh pangola grass), concentrate, cost of management and total production cost (baht/head) for each treatment in the experiment.

| Traits | T1 | T2 | T3 | P value |
|---|---|---|---|---|
| Ave. days expt. (d) | 220.50±26.18 | 176.20±6.61 | 186.75±39.19 | 0.08 |
| Cost/gain (baht/kg) | 61.04±0.70 | 59.90±6.74 | 65.46±4.94 | 0.28 |
| Roughage cost (baht/hd) | 2,918.08±209.90$^x$ | 2,393.72±179.42$^y$ | 1,714.75±202.40$^z$ | 0.01 |
| Concentrate cost (baht/hd) | 6,078.63±102.38$^y$ | 6,666.66±153.65$^y$ | 8,414.35±658.36$^x$ | 0.01 |
| Management cost (baht/hd) | 2,205.00±261.85 | 1,762.00±66.11 | 1,890.00±436.58 | 0.1 |
| Total cost (baht/hd) | 11,201.68±273.98$^{ab}$ | 10,819.54±301.34$^b$ | 11,996.60±964.62$^a$ | 0.04 |

a, b, c - *Mean values* within same row with *different superscripts are significantly different* (*P*< 0.05).
x, y, z - *Mean values* within same row with *different superscripts are significantly different* (*P*< 0.01).

Similarly (Table 2), average days of experiment (d) or number of days to reach the target weight for T1 (220.50±26.18 d) tended to be (P<0.10) higher than that of both T2 (176.20±6.61 d) and T3 (186.75±39.19 d). The number of days to reach the target weight of T2 did not differ significantly (P>0.10) to that of T3.

The feeding regime corresponding to treatments 2 or 3, at this stage, appears to be more advantageous than Treatment 1. Nevertheless, when considering investments in terms of factoring in the operating cost of feeding (Table 2), it can be seen that T2 has the lowest investment cost (Total cost. That is, it is more advantageous to feed concentrate at 1.75% body weight to the Tak beef steers under hot humid conditions.

## Conclusion

When considering the cost of investment in the context of returns in terms of average daily of gain, it could be concluded that feeding concentrate at 1.75 % of the animal's body weight with fresh Pangola grass under hot humid condition would be economically sufficient to provide gains at a satisfactory level. Further investigation should nevertheless be carried out on carcass quality in the context of roughage utilizaton.

## Acknowledgments

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