สกว
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รายงานวิจัยฉบับสมบูรณ์

โครงการ "การศึกษาเรื่องการเพิ่มช่วงแสงและการตัดขนโค เพิ่มผลผลิตในแม่โครีดนมในภาคกลางของประเทศไทย"

โดย ศ.ดร. ชาญวิทย์ วัชรพุกก์ และคณะ

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สัญญาเลขที่ BGJ/21/2543

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สนับสนุนโดยสำนักงานกองทุนสนับสนุนงานวิจัย

บทคัดย่อ

<u>โครงการที่ 1</u> บทบาทของช่วงแสงตามธรรมชาติและการเพิ่มช่วงแสง ต่อผลผลิตนมของแม่โครีดนมในภาคกลางของประเทศไทย

การศึกษาถึงบทบาทของช่วงแสงตามธรรมชาติจำนวน 12 ชั่วโมงและการเพิ่มช่วงแสงเป็น 16 ชั่วโมงต่อผลผลิตนมและองค์ประกอบน้ำนมของแม่โครีดนมกลางระยะการให้นม จำนวน 4 ตัวในแต่ละกลุ่มการทดลอง โดยที่แม่โคทุกตัวได้รับการเลี้ยงดูในโรงเรือน และได้รับหญ้าแห้งเป็นอาหารหยาบหลัก โดยเสริมอาหารข้นและกากน้ำตาล ซึ่งแม่โคกลุ่มหนึ่งได้รับช่วงแสงตามธรรมชาติ ส่วนแม่โคอีกกลุ่มหนึ่งเป็นกลุ่มที่เพิ่มช่วงแสง โดยได้รับแสงจากหลอดไฟฟลูออเรสเซนต์ในปริมาณเฉลี่ย 350 lux เพิ่มเติมหลังจากดวงอาทิตย์ตกแล้ว ผลการทดลองพบว่า แม่โคในกลุ่มที่ได้การเพิ่มช่วงแสงสามารถกินอาหารได้มากกว่าแม่โคกลุ่มที่ได้รับช่วงแสงตามธรรมชาติ (15.3 กับ 14.8 กก.วัตถุแห้ง) นอกจากนั้นแม่โคในกลุ่มที่ได้การเพิ่มช่วงแสง ให้ผลผลิตนมมากกว่าแม่โคกลุ่มที่ได้รับช่วงแสงตามธรรมชาติถึง 4.2% แต่ไม่ได้แตกต่างกันอย่างมีนัยสำคัญทางสถิติ ซึ่งอาจจะเป็นผลมาจากการเพิ่มขึ้นของฮอร์โมน Insulin like growth factor-1 ในแม่โคกลุ่มที่ได้การเพิ่มช่วงแสง แต่%ไขมันนม และ%โปรตีนในน้ำนมในแม่โคทั้งสองกลุ่มไม่ได้แตกต่างกันอย่างมีนัยสำคัญทางสถิติ.

<u>โครงการที่ 2</u> การตัดขนโคเพื่อปรับปรุงสภาพทางสรีรวิทยาและผลผลิตนมของแม่โครีดนมในทุ่งหญ้า

การศึกษาถึงพฤติกรรมการแทะเล็ม ผลผลิตนม น้ำหนักที่เปลี่ยนแปลง และการเปลี่ยนแปลงทางสรีรวิทยาในแม่โครีดนมช่วงกลางระยะการให้นม จำนวน 6 ตัวในกลุ่มแม่โคที่ได้รับการตัดขนโค และในกลุ่มมี่ไม่ได้รับการตัดขน โดยที่แม่โคทั้งหมดได้รับการเลี้ยงดูในทุ่งหญ้าเดียวกันและเป็นทุ่งหญ้าที่ไม่มีร่มเงา แม่โคทุกตัวได้รับอาหารข้นเสริมในช่วงก่อนการรีดนมทั้งสองครั้งในเวลาเช้าและบ่าย ผลการทดลองพบว่า สภาพภูมิอากาศในทุ่งหญ้าเมื่อเวลา 14.00 น. คืออุณหภูมิอากาศ อุณหภูมิการแผ่รังสี ความชื้นสัมพัทธ์ และดัชนีอุณหภูมิ-ความชื้นสัมพัทธ์ มีค่าเท่ากับ 33.9°C 38.8°C 58.4% และ 81.8 ตามลำดับ ผลผลิตนมและองค์ประกอบน้ำนมในแม่โคทั้งสองกลุ่มไม่ได้แตกต่างกันอย่างมีนัยสำคัญทางสถิติ นอกจากนั้นแม่โคทั้งสองกลุ่มยังมีอุณหภูมิร่างกาย อัตราการหายใจ อุณหภูมิผิวหนัง อัตราการขับเหงื่อ ปริมาณฮีมาโตคริต ความเข้มข้นของฮอร์โมนคอร์ติโซล ความเข้มข้นของฮอร์โมนจากต่อมธัยรอยด์ และประสิทธิภาพการทนทานต่อความร้อน ที่ไม่แตกต่างกันอย่างมีนัยสำคัญทางสถิติ แต่แม่โคที่ได้รับการตัดขนโค มีความเข้มข้นของฮีโมโกลบินต่ำกว่าแม่โคในกลุ่มอื่น อย่างมีนัยสำคัญทางสถิติ ($P<0.05$) ซึ่งแสดงให้เห็นว่าการตัดขนแม่โครีดนมที่เลี้ยงในทุ่งหญ้าไม่ก่อให้เกิดผลดีต่อทั้งผลผลิตนม และการลดความเครียดจากความร้อน

ABSTRACT

PROJECT 1: Role of natural daylength and supplemental lighting on milk production in central Thailand

The experiment was designed to examine milk yield and composition between 4 cows in mid lactation under natural photoperiod of 12 hours of daylength and 12 hours of darkness (12L:12D) and supplemental lighting of 16 hours of daylight and 8 hours of darkness (16L:8D). The cows in the latter group were provided with household-type 36 watt cool-white fluorescent bulbs to ensure a light intensity of 350 lux at cow's eye level from sunset until 2200h whilst the animal counterparts received only natural daylight until sunset. All animals were fully fed indoors with grass hay plus meal concentrate and molasses for the period of 58 days from December 1999 to February 2000. Average feed dry matter intake of the cow in the supplemental lighting group was higher than that from the natural lighting group (15.3 *vs* 14.8 kgDM). There was a trend in an increased milk yield of 4.2% from cows exposed to the 16L:8D photoperiod, although they were not significantly different. It is indicated that a possible effect of the long day photoperiod on the increase in milk yield was associated with higher concentration of circulating Insulin like growth factor-1, whilst milk composition in terms of fat and protein percentage was not significantly different between both groups of cows indicating no photoperiodic effect on milk composition.

PROJECT 2: Effect of coat clipping on heat stress amelioration and dairy performance under grazing conditions

The study was designed to investigate the grazing and ingestive behaviour, milk production, liveweight and physiological changes between 2 groups of 6 Friesian-cross cows in mid lactation; one group was coat-clipped, the second group remained unclipped as control group. All the animals grazed outdoors without shade. They were machine-milked at 0500h and 1500h daily and also fed meal concentrate twice daily at milking times according to their levels of milk production. At 1400h dry bulb and black globe temperatures averaged 33.9 and 38.8°C at the grazing site whilst relative humidity and THI averaged 58.4% and 81.8 at outdoors, respectively. Milk production (10.1 *vs* 10.6 kg/d for actual milk yield and 10.1 *vs* 10.8 kg/d for 4% FCM yield) and composition were similar in both groups. Cows in both groups had similar rectal temperatures (40.4 *vs* 40.4°C), respiratory rates (92.3 *vs* 94.8 breaths/min) and skin temperatures (41.3 *vs* 41.5°C), sweating rate (508.6 *vs* 463.2 g/m/h), haematocrit contents (24.3 *vs* 26.6%), concentrations of cortisol (5.33 *vs* 4.5 ng/ml), triiodothyronine (61.3 *vs* 66.5 ng/ml), Thyroxine (2.8 *vs* 2.9 μg/100ml), and Heat Tolerance Coefficient (70.7 *vs* 67.4). Cows in the clipped group had a statistically lower haemoglobin content than those in the unclipped group (7.0 *vs* 7.6 g/100ml; $P<0.05$). The result of the current study show that coat-clipped dairy crossbred cows subjected to solar radiation under field conditions were at no advantage, compared to unclipped ones, in terms of both heat stress amelioration and dairy production.

EXECUTIVE SUMMARY

In central Thailand, dairystock are generally confined in the open barn for safety. Exposure of cattle to light during at night has been in practice to stimulate feeding activity for milk production. Under tropical conditions of an average of temperature of 27.6°C and the average daylength of 11 to 13 hours in Thailand, supplemental lighting from natural daylength to 16 hours of light has been shown a trend for better milk yield. In fact, more total dry matter intake was found in the cows under supplemental lighting and better milk yield was expressed after 5 weeks of light supplementation. A possible effect of the supplemental lighting as long day photoperiod of 16 hours of light on the increase in milk yield was associated with higher concentration of circulating Insulin like growth factor-1. On the other hand, milk fat and protein percentage were at similar contents indicating no photoperiodic effect on milk composition. More works on this finding should be forwarded to confirm the outcome under tropical conditions.

Again, under indoor feeding in Thailand, coat clipping was proved as a successful management for better milk production and better heat stress amelioration. Lower rectal temperature, respiratory and pulse rates with higher haematocrit and haemoglobin contents were recorded for the clipped cows due to better heat dissipation. When the coat clipped cows were exposed to solar radiation under grazing conditions, there were at no advantage. Lower pasture intake and more heat dissipation in terms of both sensible and insensible (evaporative) heat loss processes were responded to the radiant heat load to maintain their thermal balance under field conditions.

PROJECT 1

ROLE OF NATURAL DAYLENGHT AND SUPPLEMENTAL LIGHTING ON MILK PRODUCITON IN CENTRAL THAILAND

INTRODUCTION

Supplementing dairy cows with 16 hours of light per day has been shown to increase milk yield by 8-10% relative to that of on natural photoperiod in the high latitude countries (Peters *et al.*, 1978; 1981; Stanisiewski *et al.*, 1985; Bilodeau *et al.*,1989; Evans and Hacker, 1989; Phillips and Schofield, 1989; Piva *et al.*, 1992; Dahl *et al.*, 1997; Miller *et al.*, 1999; Reksen *et al.*, 1999). Dahl *et al.* (1997) have investigated the ability of long photoperiods to increase circulating IGF-1, a hormone that is galactopoietic in ruminants. Increases in milk yield in cows maintained under long days are associated with a significant increase in circulating IGF-1 that is independent of changes in somatotropin levels.

In Thailand, cattle are generally confined in the open barn for safety. Exposure of cattle to light during at night has been in practice for many years to stimulate feeding activity for milk production. Under tropical conditions of an average of temperature of 27.6°C (Meteorological Department, 1998) and the range of daily daylength of 11 to 13 hours (Hydrographic Department of Royal Thai Navy, 1998) in Thailand, it is the challenge of the current work to examine how the supplemental lighting may affect dairy performance from *Bos indicus* cross dairy females in Thailand.

OBJECTIVES OF THE STUDY

To assess:

1. how the supplemental lighting has an effect on milk production relative to natural daylenght under tropical conditions.

2. the circulating concentration of IGF-1 and relevant hormones responded to the animals

MATERIALS AND METHODS

Materials

1. Animals

Eight lactating cows, all with over 75% Friesian contribution to their genotype and the remainder being a mixture of the Red Sindhi and Sahiwal (*Bos indicus*) breeds, were allocated by stratified randomisation on the basis of 1^{st} to 5^{th} lactation number, bodyweight of 384-389 kg and previous milk yield to one of the 2 treatments. All cows were 120 days into their current lactation when allocated.

2. Feed

Guinea (*Panicum maximum*) grass hay was fed *ad libitum* to animals plus an amount of a commercial meal concentrate. Molasses were also fed to ensure sufficient energy requirement for milk production. Mineral supplement and clean water were freely accessed.

3. Housing and Light Facilities

Two open-sided loose housing barns (each 12 m long x 7 m wide x 3.5 m high and along east west with a tiled roof) were used to house 4 cows for each treatment. Each barn was 30 m away from each other and shielded from stray light. A number of 36 watt cool-white fluorescent bulbs were set up to provide the required light intensity of 350 lux at animal height in the experimental group.

4 Accessories

Scale, blood collection set (needle, syringes, glass tubes and plastic bottles for serum), Lux Meter (TES-1330), materials for internal and external parasite control were provided

Methods

1. The experiment compared 2 treatments of cattle viz.,

Treatment 1: 4 lactating cows were assigned into the control group indicated as the natural daylight group. The control group was provided with natural daylight being 12 and a half hours of light and dark period of 11 and a half hours (12L:12D) without any artificial lighting arrangements. The only light entering this barn was thus natural daylight which was allowed through the open sides. All cows were unrestrained and fully fed in a barn of 12 m long x 7 m wide x 3.5 m high with tiled roof and oriented to east-west.

Treatment 2: 4 lactating cows were under artificial lighting arrangements, indicated as the supplemental lighting group. The housing barn the experimental group was provided with household-type 36 watt cool fluorescent bulbs. The bulbs were located 3 m above the floor. The lighting facilities described provided at cow's eye level (120 cm from the floor), a light intensity of 350 lux (Dahl *et al.*, 1997). Incorporated in the lighting circuit of the experimental barn was an automatic time switch which allowed the lights to be switched on and off automatically before sunset at 1730 h until 2200 h, making total of 16 hours of light and 8 hours of darkness (16L:8D). The barn for this group of animals was as the same size as indicated in Treatment 1.

2. All cows were fed commercial according to their individual milk production at 1 kg of concentrate to 1.5 kg of milk produced, divided between morning and afternoon milking times and all concentrate was consumed. In addition, 1 kg of molasses was provided to each cow by group feeding in both treatments.

3. The cows were measured at the start of the experiment and every fortnightly.

4. Weekly means of hay intake in each treatment was estimated 6 times (once in December, 1999, 4 times in January and twice in February, 2000) as the difference between daily hay offered and the residual uneaten hay. Hay and concentrate sampling were done every monthly for dry matter (DM) determination by drying at 70-80°C for 36 hours,

estimation of nitrogen (N) content using the Kjeldahl method by the Tecator Kjeltec System (1002 Distilling Unit), and IVDMD (Tilley and Terry, 1963) for roughage and meal concentrate. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) determination (van Soest, 1967) were also estimated for fibre content in grass hay fed. In addition, molasses were also estimated for DM determination, N content using the same methods as mentioned above and gross energy (GE) using automatic adiabatic bomb calorimeter (Gallenkamp Autobomb).

5. Daily milk yield was recorded for each cow at each milking and an individually composite sample of morning and afternoon milk was analysed at weekly intervals for fat and protein contents using the Milkoscan milk tester at Tab-kwang Artificial Breeding Centre. Yield of 4%FCM was calculated (Walker *et al.*, 2001) as follows,

FCM (kg/cow/day) = milk yield (kg/cow/day) x [0.4+ {0.015 x fat content (g/kg)}]

7. A technique (Blowey *et al.*, 1973) to assess the nutritional status of dairy cows in relation to production was applied. To accommodate that technique, morning supplementation was delayed until after milking on that day only. Blood samples of 10 ml were taken from the jugular vein on one occasion during the experimental period. They were collected at 0730h before meal concentrate supplementation, and again separately at 1330h, before the afternoon milking (4-5 hours after morning supplementation). The samples were also heparinised, centrifuged and stored at -20°C for BUN and glucose determination. The BUN was analysed by automated spectrophotometer (Cobas Mira, Roche) using the technique reported by Tiffany *et al.* (1972) and plasma glucose by a modification of the enyzmatic technique of Slein (1963) using Cobas Mira, Roche.

8. Blood samples of 10 ml were taken from the jugular vein on one occasion during the experimental period. They were collected at 1330 h, and heparinised, centrifuged and stored at -20°C for plasma IGF-1 by IGF-1 OCTEIA ELISA 96 Wells (Immunodiagnostic Systems, UK).

9. Monthly measurement of light intensity was tested on December 28, 1999, January 13 and February 10, 2000, with a Lux Meter. The measurements were made between 1900 h to 2000 h at about cow's eye.

10. Meteorological data in terms of maximum and minimum temperatures, relative humidity (RH), wind velocity and amount of rainfall were collected monthly in a Stephenson screen located 300 m from the experimental barns. The monthly on-farm details on natural photoperiod during the years 1994-1998 at Muaklek Saraburi are presented in Table 1.

Table 1 Mean daylength (hours:minutes) throughout the years 1994-1998 at Muaklek area

Month	Year					
	1994	1995	1996	1997	1998	Mean
Jan	11:22	11:22	11:22	11:22	11:22	11.22
Feb	11:40	11:40	11:40	11:40	11:40	11.40
Mar	12:02	12:04	12:02	12:04	12:04	12.03
Apr	12:28	12:28	12:28	12:28	12:28	12.28
May	12:50	12:49	12:50	12:50	12:50	12.50
Jun	13:01	13:01	12:59	12:59	12:59	12.59
Jul	12:55	12:55	12:55	12:55	12:55	12.55
Aug	12:37	12:37	12:37	12:37	12:37	12.37
Sep	12:13	12:13	12:13	12:13	12:13	12.13
Oct	11:48	11:48	11:48	11:49	11:49	11.48
Nov	11:27	11:27	11:27	11:27	11:27	11.27
Dec	11:17	11:17	11:17	11:17	11:17	11.17

Source : Hydrographic Department of the Royal Thai Navy (1998)

11. The t-test using PROC TTEST by SAS (1985) was applied to determine significance of milk yield and milk composition, LW changes, BUN and plasma glucose.

12. The experiment was conducted at the Dairy Farming Promotion Oreganisation of Thailand (DPO), Muaklek, Saraburi (lat. 14°C 50'N, long. 101°C 10'E, altitude 220 m). A pre-experimental period for cows to adapt to procedures of 7 days was allowed. Then the 8-week experiment began on December 13, 1999 and terminated on February 9, 2000.

RESULTS AND DISCUSSION

Results

1. Climatological Data

Table 2 Climatological data throughout the experimental period

	Wind (m/s)	DBT (°C) Max	DBT (°C) Min	RH (%)	Rainfall (mm)
Dec	1.7	25.9	15.4	59.7	-
Jan	0.9	30.7	17.6	71.7	19.54
Feb	1.2	30.8	18.0	67.4	4.0
Mean	1.3	29.1	17.0	66.4	7.8

Monthly means of maximum-minimum temperatures, the amount of rainfall, wind velocity and RH during the experimental period are indicated in Table 2. The animals in each barn were subjected to the hot-dry environment during the cool season of the year (Nuttonson, 1963; Gates, 1968). The animals would be expected to have a lower indoor temperature due to the reduction of solar radiant heat load by 30% or more (Bond *et al.*, 1967).

2. Feed Quality, Feed Intake, Liveweight Change and Blood Metabolites

High DM content, NDF and ADF concentrations with low CP and digestibility levels in grass hay (Table 3) would be expected to be a limitation to milk production. Then the high quality meal concentrate of high CP and IVDMD contents (Table 3) was supplemented. In addition, molasses was also provided to ensure that the animals should have a sufficient energy for their production requirements.

Table 3 Quality of feed provided to all cows throughout the study

	DM (%)	CP (%)	NDF (%)	ADF (%)	IVDMD (%)	GE (kcal/kgDM)
Hay	91.0	5.7	75.5	49.8	33.4	-
Conc	90.5	22.2	-	-	73.8	-
Molasses	78.4	3.6	-	-	-	3744.4

Estimated daily meal concentrate and molasses intake of each animal in both groups was 5.8 and 0.8 kgDM, respectively whilst estimated daily hay intake were 8.2 and 8.7 kgDM/cow for the 12L:12D and the 16L:8D Groups, respectively, making a total DM intake of 14.8 and 15.3 kgDM/cow for the cows under the 12L:12D and the 16L:8D Groups, respectively.

3. Light Intensity

Mean light intensity recorded at eye level of the cow in the long day photoperiod group were 426 lux (318 to 440 lux), and 421.9 lux (335 to 434) and 393.9 lux (333 to 424lux) in December 1999, January 2000 and February 2000, respectively.

Table 4 Mean liveweight changes of cows (kg/cow) in either 12L:12D or 16L:8D Group

	12L:12D Group	16L:8D Group
Initial LW	389.25±19.6	384.25±12.5
2^{nd} LW	398.0±11.3	385.5±13.8
3^{rd} LW	419.0±13.5	404.0±10.3
4^{th} LW	404.0±12.8	392.0±15.0
Final LW	417.5±14.7	399.5±16.8
LW differences	+28.3	+14.3

Mean±SD

LW gains during the study (Table 4) were 28.3 and 14.3 kg for the 12L:12D and the 16L:8D, respectively. The weekly readings were not significantly different.

BUN and blood glucose concentrations for the two treatments are shown in Table 5, with the mean BUN and glucose levels showed no significant difference between the two groups.

Table 5 Blood urea nitrogen and glucose of cows in either 12L:12D or 16L:8D Group

	12L:12D Group (mg%)	16L:8D Group (mg%)
BUN: AM feeding	13.9±5.2	15.8±3.4
PM feeding	18.4±6.9	18.7±4.7
Glucose: AM feeding	52.8±0.8	52.0±2.3
PM feeding	56.0±0.7	54.5±4.0

Mean±SD

Table 6 Means of actual milk and FCM yields (kg/cow) in either 12L:12D or 16L:8D Group

Week	Actual milk yield		FCM yield	
	12L:12D	16L:8D	12L:12D	16L:8D
0	10.6±2.6	10.5±1.5	11.1±2.8	10.9±1.5
1	9.9±2.9	9.9±1.2	10.1±2.9	10.2±1.3
2	9.9±2.2	9.3±1.5	10.3±2.3	9.7±1.7
3	9.5±2.5	8.9±1.3	9.9±2.7	9.3±1.4
4	9.6±2.2	8.9±1.6	9.9±2.3	9.1±1.6
5	9.3±2.4	9.6±1.4	9.6±2.5	9.8±1.5
6	9.5±1.7	9.8±1.5	10.1±1.9	10.1±1.6
7	9.6±2.2	10.4±1.9	9.7±2.3	10.9±2.1
8	9.9±2.4	9.4±1.2	10.3±2.5	10.0±1.3
9	9.1±2.8	8.9±1.7	9.6±2.9	9.3±1.7
Mean	9.6	9.4	9.9	9.8

Mean±SD

4. Milk Production and Milk Composition

The average daily actual milk and FCM yields of cows in both treatments throughout the study were not significantly different (Table 6). When considering cows in the 16L:8D Group from weeks 1 to 4, daily FCM yield was lower than their counterparts in the 12L:12D Group (Table 7; Figure 1), even it was not significantly different.

Table 7 FCM yield of cow (kg/cow) exposed to 16L:8D and 12L:12D during weeks 1-4 and during weeks 5-9

	16L:8D	12L:12D
Weeks 1-4	9.6±1.4	10.1±2.4
Weeks 5-9	10.0±1.5	9.8±2.3

Mean±SD

However, after 4 weeks of long day photoperiod in Table 7 an average milk yield of cows exposed to 16L:8D was increased in relative to those of the first 4 weeks of supplemental lighting, making an average of 4.2% increase in milk yield from the 16L:8D cows.

Table 8 Milk composition of cows in either 12L:12D or 16L:8D Group

	16L:8D	12L:12D
Fat (%)	4.3±0.11	4.3±0.12
Protein (%)	3.0±0.16	3.0±0.11

Mean±SD

There were not any photoperiodic effect on the percentage of fat and protein, as shown in Table 8 due to their non-significantly differences in both parameters under 16L:8D and 12L12D Groups.

5. Concentration of Circulating Insulin-Like Growth Factor-1 Changes

There was non-significantly different IGF-1 levels between cows under 16L:8D and 12L:12D Groups, as indicated in Table 9.

Table 9 Concentrations of circulating Insulin-like growth factor-1 of cows in either 12L:12D or 16L:8D Group

	16L:8D Group (ng/ml)	12L:12D Group (ng/ml)
IGF-1	49.25±10.3	45.25±9.9

Mean±SD

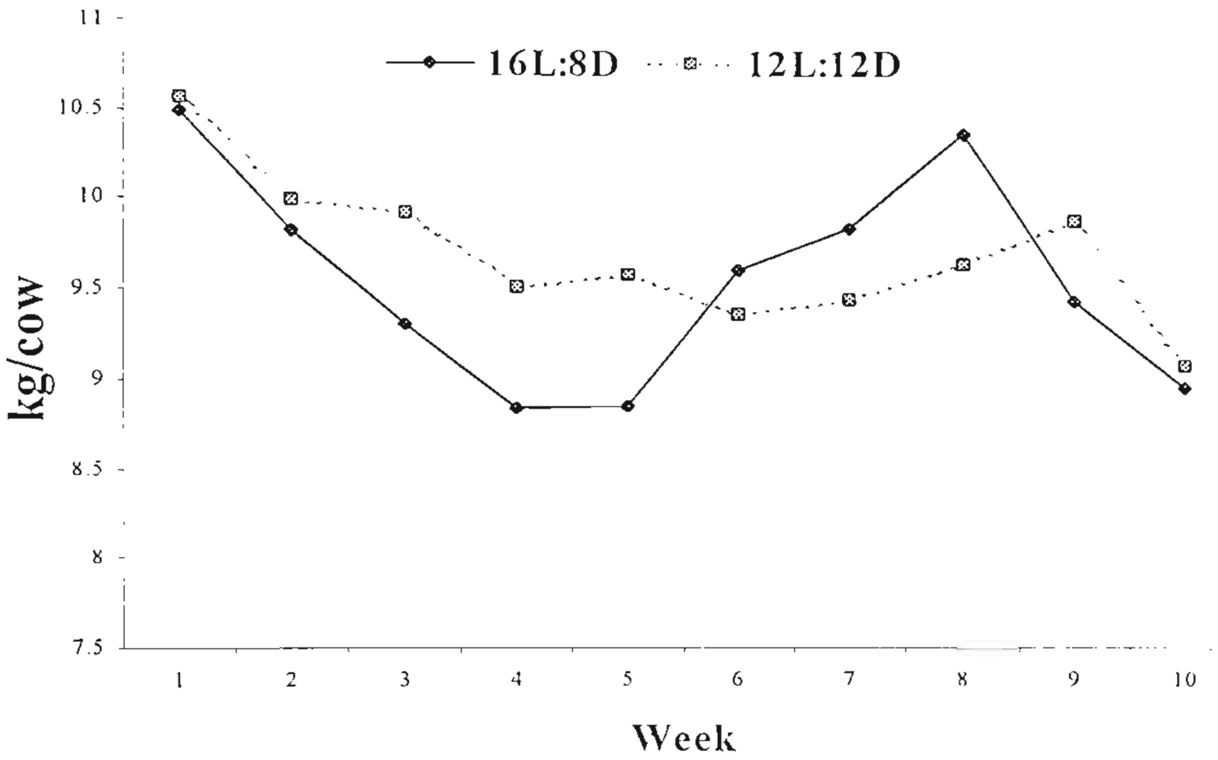

Figure 1 Weekly FCM yield per cow in either 12L:12D or 16L:8D Group

Discussion

The annual ET cycle generally follows, with some lag, the yearly daylength cycle, resulting in shorter daytime and cooler ET (Curtis, 1987). However, this investigation was conducted during the cool months of the year in the tropics (Nuttonson, 1963) with a narrow range of daylength approximately 11 hours of daylight and 13 hours of darkness (Table 1). With the wide range of temperature from 17 to 29.1°C (Table 2), the ET during daytime might exceed 26°C, so heat stress would have occurred to affect neuroendocrinological changes (Yousef and Johnson, 1985) and production was likely to fall (Johnson *et al.*, 1961). In fact, lactating cows are more susceptible to heat stress during the first 60 days postpartum, however, the mid-lactationed cows in this experiment would be expected to have less influence from environmental heat stress (McDowell *et al.*, 1976).

Under poor nutritional values of grass hay in Table 3, meal concentrate and molasses could support their nutritional requirement for maintenance and production (NRC, 1989). BUN and blood glucose were above the standard range of 12.3 to 17.8 mg% for BUN (Rowlands *et al.*, 1977) and of 42.5 to 45.4 mg% for plasma glucose (Payne *et al.*, 1974; Rowlands *et al.*, 1977) indicating a sufficient dietary requirement the animals might have for their production.

Continuous lighting during night-time has been in practice for security in Thailand, it was also effective in stimulating an increase in feed intake (Tanida *et al.*, 1984). However, lactating cows exposed to 16L:8D photoperiod consumed 4.7% more daily hay DM intake than their counterparts given 12L:12D photoperiod making up a higher total DM intake (14.3 vs 15.3 kgDM/d) (Peters *et al.*, 1981; Tanida *et al.*, 1984; Stanisiewski *et al.*, 1985). The increase in total DM intake was expected to supply greater demand for energy output from the mammary gland for galactpoietic in cattle (Dahl *et al.*, 1991; 2000).

In practice, an increase in bodyweight of the mid-lactationed cows as lactation advanced indicate that they are considered to partition more energy to body reserve than to milk production (Chilliard, 1989). However, the cows exposed to 16L:8D photoperiod gained less LW at the end of the experiment, possibly due to more energy from dramatic increase in feed intake partitioned to milk production during supplemental lighting (Dahl *et al.*, 2000).

There are number of reports in the literature (Peters *et al.*, 1978; 1981; Mercek and Swanson, 1984; Bilodeau *et al.*, 1989; Dahl *et al.*, 1997) reporting that at high latitudes and in the temperate zone, supplemental lighting can increase milk yield. The current result from a short-term study of 9 weeks under tropical conditions shows that cows responded to the long day photoperiod after 4 weeks of supplemental lighting possibly indicating an increased milk yield from the 16L:8D relative to the 12L:12D periods (9.6 vs 10.0 kg/d). An average of 4.2% increase in FCM yield from cows exposed to 16L:8D was obtained (Table 7, Figure 1). Possibilities of long day photoperiod are able to stimulate the increased milk yield in the current study could have been due to 2 factors. One possibility is the effect of photoperiod on feed intake which can be suggested that the additional feed consumed would be available for milk synthesis (Peters *et al.*, 1981; Bilodeau *et al.*, 1989). The second one is due to circulating IGF-1 changes (Dahl *et al.*, 2000).

Endocrine mechanism that mediates the increase in milk yield of cows exposed to long day photoperiod has recently been investigated by Dahl *et al.* (1997). Dahl *et al.* found that a long daily photoperiod increases circulating concentrations of IGF-1 in lactating cows. The current study shows that cows exposed to 16L:8D photoperiod had a higher IGF-1 levels relative to the 12L:12D. However, their concentrations were not significantly different between two treatments, there was a trend to increase milk yield after 4 weeks of supplemental lighting (Figure 1).

In addition, mean light intensity of 394-427 lux in the supplemental lighting barn would be effective to stimulate the hormonal changes on secretion of PRL and IGF-1 on milk production (Peters and Tucker, 1977; Peters *et al.*, 1978; Leining *et al.*, 1979). PRL is known for the most responsive to changes in photoperiod (Bourne and Tucker, 1975) and ambient temperature (Wetteman and Tucker, 1974). However, there was no PRL assay in this experiment and there is no unequivocal evidence that PRL is responsible for the galactopoietic response to long day photoperiod (Tucker, 1994; 2000). Then, the alternative indicator to explain the response from long day photoperiodic effects would be the circulating IGF-1. Dahl *et al.* (1997) reviewed a number of studies of galactopoietic effects from the 16L:8D indicating the response of 16L:8D photoperiod on an increase of 6.5% milk yield. With regard to the current result, the long day photoperiod may be acting via increases in circulating IGF-1 and cows exposed to 16L:8D Group had greater circulating concentrations of IGF-1 than did cows in the 12L:12D Groups (49.25 vs 45.25 ng/ml) and that an increase 4.2% of milk yield was from the 16L:8D Group. In contrast, long day photoperiod did not affect milk composition in terms of fat and protein percentage (Bilodeau *et al.*, 1989; Dahl *et al.*, 1997). Generally, milk yield is inversely related to milk fat percentage (Rook and Campling, 1965). However, milk fat percentage from the 16L:8D was similar to that from the 12L:12D, possibly due to their advanced lactation to late lactation period (Larson, 1985).

It can be expressed that this experiment has possibly provided a support for the use of photoperiod as an effective, non-invasive method to enhance milk production. Details on number of cows and hormonal responses from PRL and IGF-1 are needed to an increase in milk production under tropical conditions.

PROJECT 2

EFFECT OF COAT CLIPPING ON HEAT STRESS AMELIORATION AND DAIRY PERFORMANCE UNDER GRAZING CONDITIONS

INTRODUCTION

It has been shown in the previous experiment that cows can be grazed in pasture under conditions in Central Thailand without any production losses. On the other hand effective low cost strategies are required to improve physiological responses. The provision of shelter in the field in terms of shade trees and artificial shade has already been shown to lower "heat load" within the shelter and to have a beneficial effect on cutaneous evaporation, body temperature and milk production (Murray, 1966; Davison *et al.*, 1988). Clipping of dairy cattle is one of the ameliorative measures which has been shown to cause a decline in both rectal temperature and respiratory rate which could not be attributed to increased non-evaporative heat loss in psychrometric studies (Yeates, 1955; Berman and Kibler, 1959; Bianca, 1959 and Vajrabukka, 1978). By removing the physical barrier per se and despite the fact that the amount of sweat on the skin is relatively smaller in the clipped coat animals, the sweat is utilised to cool the animals more efficiently when compared to woolly coat type animals (Dowling, 1958; Bianca, 1959 and Bennett, 1964).

For the first time in Thailand, Boonprong (1999) recently found that clipped lactating cows when fully fed indoors, have highly significant decreases in sweating rate, body temperature, respiration rate and pulse rate. Additionally, the average milk production was 3 kg higher in the clipped animals than in their unclipped counterparts. Clipping the coat under indoor conditions not only has a potential to improve the physiological conditions but also promotes milk production.

OBJECTIVES OF THE STUDY

The current study was undertaken to investigate the potential effect of clipping on pasture intake, milk production, bodyweight changes and health status of lactating cows under grazing conditions. In addition the physiological responses in terms of body temperature, respiratory rate, skin temperature, sweating rate, circulating cortisol concentrations, Thyroid hormones in terms of Triiodothyronine (T_3) and Thyroxine (T_4) contents and haematological (haemoglobin and haematocrit) levels have also been examined in the current work.

MATERIALS AND METHODS

Materials

1. Animals

Twelve cows, all with over 75% Friesian contribution to their genotype, were allocated by stratified randomisation on the basis of 1st to 5th lactation number, average LW of 408 kg and previous milk yield to one of 2 treatments. All cows were 120 to 150 days into their current mid lactation when allocated.

2. Feed

Established areas of tropical grass pasture, mainly purple guinea grass (*Panicum maximum* var. purple guinea) were provided for the cattle. Pasture was formerly utilised for the on-farm dairy stock (see Prasanpanich, 2001). Since then, it had been fertilised and irrigated till the start of the current experiment. Commercial meal concentrate was fed to the cows twice daily prior to bucket-machine milking. An average meal concentrate of 3 kg was provided to all animals to provide for their individual requirement according to milk production and stage of lactation (NRC, 1989).

3. Pasture Facilities

Electric fencing was used to control the area grazed each day with the back fences behind the animals to prevent them from grazing the young pasture regrowth. Fertiliser at the rate of 25 kg/rai of urea was applied after each pasture slashing (Stobbs, 1971; Davison *et al.*, 1981; Buchanan *et al.*, 1985). Sprinkler irrigation was also supplied at 7-9 day interval to ensure optimal soil moisture conditions for pasture regrowth. Rotational grazing/cutting was practiced with an average interval of 35 days (range 30 to 40 days).

4. Accessories

Scales for LW measurement, an electric hair clipper (Rinderschermaschine LAB Typ 2500-R, Germany), drugs for internal and external parasites, climatological equipments, clinical thermometer, stopwatch, cobalt chloride disc, and blood sampling kits were provided. Veterinary treatments were also given to the animals when needed.

Methods

1. The experiment compared 2 groups of cattle viz.,

Treatment 1: 6 lactating cows were daily strip-grazed for 24 hours on a shade-less paddock about 300 m distance to the milking barn.

Treatment 2: 6 lactating cows were fortnightly clipped and also daily strip-grazed on the same paddock, as for treatment 1.

2. The stocking rate was at 24 cows per rai (150 beasts/ha). All the animals were absent from twice daily bucket-machine milking in the same barn. Clipping the coat was done one day before the start of the experiment with an electric clipper and at 7 day interval thereafter, which produced a short coat leaving just enough hair to cover the skin and protect it from radiation. The whole body was clipped with the exception of head, ears, tail switch and legs below the knee or hock. The coat type of each animal was scored on the scale of 1 to 7 with fractional subdivisions, following the method of Turner and Schleger (1960), shown in Table 10, immediately before and after each clipping on the same occasion.

3. LW was measured before the start of the experiment and again fortnightly. Daily milk production was recorded and weekly samples for estimation of composition were collected from 2 consecutive milkings. A composite sample of morning and evening milk was analysed for the percentages of milk fat, protein, lactose, SNF, and TS by use of a Milkoscan milk tester at the Artificial Insemination Centre, Department of Livestock Development, Tab-kwang, Saraburi. Yield of FCM was calculated (Walker *et al.*, 2001) as indicated in Project 1.

4. The forage available in each paddock before grazing/cutting was estimated by cutting 8 random quadrats (each 0.25 m^2) with hand shears to a height of 8 cm. The material from each quadrat in the pre-grazing measurement was separated into green leaf, stem and dead material. This operation was always made by the same operator to mininise the variability associated with the technique (Thompson, 1986). Pasture samples were collected and washed to remove soil contamination and dried at 70-80°C for 36 hours for DM determination and estimation of N content using the Kjeldahl method by the Tecator Kjeltec System (1002 Distilling Unit), IVDMD (Tilley and Terry, 1963), NDF and ADF

determination (van Soest, 1967) by Fibre Tech (VELP Scientifica, Type FIWE, Italy). Hand sorting of forage into green leaf, green stem and dead components (Hoult and Bryant, 1974) was also conducted during each pasture yield measurement.

Table 10 The coat score system of Turner and Schleger (1960)

Coat score	Coat Type	Description
1	Extremely short	Hairs extremely short and close applied to the skin. Found in Zebus, in some of their crossbreds, and very rarely in mature Hereford or Shorthorn cows in summer.
2	Very short	Coat sleek, hair short and coarse, lying flat able to be lifted by the thumb.
3	Fairly short	General appearance smooth-coated. Hair easily lifted, usually fairly coarse.
4	Fairly long	Coat not completely smooth, somewhat rough, patches of hairs being curved to outwards, or whole coat showing sufficient length to be ruffled.
5	Long	Hair distinctly long and lying loosely; predominantly coarse.
6	Woolly	Hairs erect, giving fur-like appearance. Fingers are partly buried in the coat. Fine hairs of under-coat give soft handle.
7	Very woolly	The more extreme expression of 6, with greater length and "body", and heavy coat cover extending to neck and rump.

5. The meal concentrate was analysed for DM content, IVDMD by (Tilley and Terry, 1963) and CP based on N content using the Kjeldahl method as indicated in Project 1.

6. A technique (Blowey *et al*., 1973) to assess the nutritional status of dairy cows in relation to production was applied. To accommodate that technique, morning supplementation was delayed until after milking on that day only. Blood samples of 10 ml were taken from the jugular vein on one occasion during the experimental period. They were collected at 0730 h in the morning, before meal concentrate supplementation, and again separately at 1330 h before the afternoon milking (4-5 hours after morning supplementation). The samples heparinised, centrifused and

stored at -20°C for BUN and glucose determination. The BUN was analysed by automated spectrophotometer (Cobas Mira, Roche) using the technique reported by Tiffany *et al.* (1972) and plasma glucose by a modification of the enzymatic technique of Slein (1963) using Cobas Mira, Roche.

7. Separate blood samples of 10 ml were taken from the jugular vein on one occasion during the experimental period. They were collected at 1300h and heparinised, centrifused and stored at -20°C for later analyses for Ht (Micro-haematocrit; Benjamin, 1978), Hb (Acid-haematin; Horwitz, 1990), plasma cortisol (by RIA kits, Coat-a-count® Cortisol, Diagnostic Products Corporation, Los Angeles, CA, USA), T_3 and T_4 (by RIA kits, Coat-a-count® T_3, T_4 Diagnostic Products Corporation, Los Angeles CA, USA).

8. Once weekly for 8 weeks, at 1330 h, the following physiological responses were measured in terms of respiratory rate (RR), rectal temperature (RT), skin temperature (ST), and sweating rate (SR). RR was measured by visual observation (using a stopwatch and counting uninterrupted flank movements counted for 1 minute). A clinical thermometer was inserted 10 cm into the rectum for 1 minute to record RT. ST was measured by clinical thermometer placed in a skin fold on the upper shoulder for 5 minutes. SR was measured by a modification of the method of Schleger and Turner (1965), which is based on the time taken for paper discs impregnated with cobalt chloride to change from blue to pink colour. Filter paper no. 41 prepared by immersion in a 10% cobalt chloride solution and then fried at room temperature on a sheet glass. The paper was oven-dried (50°C) and discs (53 mm in diametre) were punched out and redried. Three discs were then mounted on the midline of a 75-mm strip of 20-mm cellulose adhesive tape, which was then fixed to a 75 × 25-mm glass slide, and then stored in a dessicator. A 20×20 cm patch on the mid-side position on each animal was shaved prior to the measurement. An adhesive strip with discs was removed from the slide and placed on the skin, which has been wiped dry. The mean time taken for the three discs to change colour was recorded with sweating rate using the following equation (Schleger and Turner, 1965);

$$\mathbf{SR\ \{g/(m^2.h)\} = 3.84 \times 10^4/t}$$

where t = time in second

To this end, cows in both groups were temporarily restrained with halters, outdoors as appropriate, and all measurements were recorded on each cow random order. Heat Tolerance Coefficient (HTC) was also calculated using the equation of Rhoad (1944);

HTC = **100 – 10 (BT –NT)**
where BT = body temperature at that environment (°C)
NT = 38.6°C

9. A set of daily on-farm meteorological data in terms of maximum and minimum air temperatures, relative humidity (RH) by the conversion of dry bulb temperature (DBT) and wet bulb temperature (WBT) measured by dry bulb and wet bulb Thermometer, rainfall, wind velocity were collected in a Stephenson screen located in the grazing area, shown in Table 11. The collection of DBT, BGT, RH at 1400 h at the pasture site and THI calculated using the equation for Friesian lactating cows from McDowell (1972), were also recorded and are presented in Table 12.

THI = **0.72 (DBT + WBT) + 40**

Table 11 Average on-farm meteorological data throughout the experiment and at 0800 h

Month	Overall Mean				Mean at 0800 h		
	DBT (°C)		Rainfall	Wind	DBT	RH	THI
	Max	Min	(mm)	M/s	(°C)	(%)	
Mar	33.7	22.0	19.5	1.4	25.8	63.7	77.9
Apr	32.5	23.2	234.5	1.1	27.8	80.9	78.7
May	32.2	22.3	14.6	0.9	26.4	92.0	77.9
Mean	32.8	22.5	89.5	1.1	27.4	78.9	78.1

10. Four observations of the eating patterns of each animal were made in terms of grazing, ruminating and idling (with or without panting) on April 8, 15, 22 and 29, 2000. The observations were totalled by hourly interval over all 24 hours apart from milking times and expressed as percentages. Differences for each hour were evaluated with the Chi-Square Test (Martin and Bateson, 1986).