BENEFITS OF AUTOMATED ACCLIMATIZATION DURING THE PRE-MILKING PHASE OF LACTATING GIROLANDO COWS

IRENILSON M. DA SILVA[1], HÉLITON PANDORFI[2], GLEDSON L. P. ALMEIDA[1], CRISTIANE GUISELINI[2], HUGO M. HENRIQUE[3]

ABSTRACT: The aim of this paper was to evaluate the automated acclimatization effects during pre-milking of cows on thermal conditioning, physiology, milk production and cost-benefit of the automated adiabatic evaporative cooling system (AECS). The treatments 20; 30; 40 min and control consisted of exposure time of pre-milking cows to the automated AECS. Sixteen cows were used with an average daily milk yield of 19 kg, distributed in a 4 x 4 Latin square design. The Tukey's test ($P<0.05$) was used to compare the means. The environmental variables, dry bulb temperature (DBT, ºC) and relative humidity (RH, %), were recorded every minute, which allowed the determination of the system efficiency through the Temperature and Humidity Index (THI). The respiratory rate (RR), rectal temperature (RT) and temperature of the coat (TC) were measured before and after the acclimatization. The 40 min treatment kept the environmental variables and the comfort indexes within recommended limits. The physiological variables (RR, RT and TC) were lower in the 40 min treatment and reflected positively on milk production, which increased 3.66% compared to the control treatment. The system was profitable, having a 43 days return on investment and a monthly revenue increase of R$ 1,992.67.

KEYWORDS: thermal comfort, automation, dairy cattle, evaporative cooling system.

BENEFÍCIOS DA CLIMATIZAÇÃO AUTOMATIZADA NA PRÉ-ORDENHA DE VACAS GIROLANDO EM LACTAÇÃO

RESUMO: Objetivou-se com esta pesquisa avaliar os efeitos da climatização na pré-ordenha sobre o acondicionamento térmico, fisiologia, produção de leite e relação custo/benefício do sistema de resfriamento adiabático evaporativo (SRAE) automatizado. Os tratamentos adotados foram os tempos de exposição dos animais ao SRAE no curral de espera, 20; 30; 40 min e o tratamento-controle. Utilizaram-se 16 vacas com produção de 19 kg de leite dia^{-1}, adotando-se delineamento em quadrado latino 4 x 4 e comparação entre as médias pelo teste de Tukey ($P<0,05$). Foram registradas as variáveis ambientais temperatura de bulbo seco (Tbs) e umidade relativa (UR) a cada minuto, o que permitiu determinar a eficiência do sistema por meio do índice de temperatura e umidade (ITU). A frequência respiratória (FR), temperatura retal (TR) e temperatura de pelame (TP) foram medidas antes e depois da climatização. O tratamento 40 min permitiu manter as variáveis ambientais e os índices de conforto entre os limites recomendados. As variáveis fisiológicas (FR, TR e TP) mostraram valores inferiores no tratamento 40 min, com aumento de 3,66% na produção de leite, quando comparado com o controle. O investimento promoveu acréscimo na receita mensal de R$ 1.992,67 com tempo de retorno do capital de 43 dias.

PALAVRAS-CHAVE: conforto térmico, automação, bovinocultura de leite, resfriamento evaporativo.

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[1] Engº Agrícola, Mestre em Engenharia Agrícola, UFRPE, irenilsonmachado@yahoo.com, gledson81@hotmail.com.
[2] Engº. Agrônomo, Prof. Adjunto, Departamento de Tecnologia Rural, UFRPE, Recife - PE.
[3] Acadêmico em Engenharia Agrícola e Ambiental, UFRPE.
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INTRODUCTION

Cattle susceptibility to thermal stress increases as the relative humidity and temperature exceed the thermal comfort zone, making heat dissipation more difficult, which affects the production efficiency due to the higher energy expenditure for maintenance, with a negative effect on animal performance (FERREIRA et al., 2006).

According to FERREIRA et al. (2009), cattle defend themselves against heat stress by using adaptive physiological mechanisms of body heat loss to prevent hyperthermia. Thus, these increase respiratory rate as an additional mechanism to heat loss through sweat, both being important mechanisms of heat loss via evaporation.

The main function of facilities is to offer comfort to the animal, in order to allow it to express full production potential. These ought to be built and designed with the primary purpose of reducing the action of weather elements (sunlight, temperature, wind, rainfall and relative humidity) that may promote undesirable effects to the animals. The environmental variables are controlled with different construction materials, design of physical space available, density, and system of ventilation and cooling (SOUZA et al., 2007).

The waiting shed, a facility attached to the milking parlor is, on most farms, the most stressful area for lactating cows. When the animal is confined in the shed waiting for 15 to 60 minutes, two or three times a day, stress can occur even at a moderate temperature (LIMA et al., 2007). The efficiency of the adiabatic evaporative cooling system (AECS) by water spraying or fogging associated with forced ventilation was evaluated in tropical climate, with positive effect on thermal comfort, behavior and animal performance (PERISSINOTTO et al., 2006; ALMEIDA et al., 2010).

The values of potential reduction of air temperature showed variation inversely proportional to the relative humidity (RH), since the cooling process implies moisture increase in the environment. For the same temperature, when RH increases, vapor pressure deficit is reduced, but also the air capability of taking up moisture. The efficiency of evaporative cooling is directly proportional to the local vapor pressure deficit (CARVALHO et al., 2009). ALMEIDA et al. (2010) reached high RH by applying AECS in the waiting shed. The values found were 74.8 and 77.5% for treatments with cooling times of 20 and 30 min, respectively.

The need farms have shown in recent years, in relation to continuous improvement in their levels of quality, productivity and competitiveness, also involves the development of innovative solutions with different automation levels (BOTEGA et al., 2008).

Automation can help the sustainability of both, the production process as well as economic and social development. Therefore, the use of automated AECS is presented as a good solution in order to improve milk production quantitatively and qualitatively in the northeastern region of Brazil.

In this context, the aim of this research was to assess and quantify the effects of acclimatization in waiting shed on the environmental thermal condition, physiological state, milk production and cost/benefit of automated AECS.

MATERIAL AND METHODS

The work was carried out in a commercial property for production of type B milk, Roçadinho Farm, in the municipality of Capoeira, PE, latitude 8º36’33” S, longitude 36º37’30” W and altitude of 733 m. The rainfall in the region is 588 mm year^{-1}, with average annual temperature of 22.1 °C and daily global solar radiation annual average of 21.4 MJ m^{-2} day^{-1} (BARROS et al., 1998). According to Köeppen’s climate classification, the local climate is characterized as Bsh, semi-arid (VIANELLO & ALVES, 2006).

The experiment was conducted during summer (January-February 2010), lasting 56 days, which were divided into four periods (P1, P2, P3 and P4), totaling seven days for each trial. Seven days were used for animal adaptation to the adiabatic evaporative cooling system (AECS) before starting the automated data logging. After the adjustment period, meteorological variables were recorded for each treatment and the variables external to the installation, along with physiological and production data of the animals.

As treatments, three acclimatization times were considered in the waiting shed, 20; 30; 40 min, and the control treatment (without acclimatization), in which animals were exposed to automated SRAE before milking.

Sixteen lactating multiparous “Girolando” cows were selected, which genetic composition consisted of 7/8 Holstein-Gir, with an average weight of 500 kg and average milk yield of 19 ± 0.76 kg day^{-1}, randomly divided into four groups (G1, G2, G3 and G4) with four animals per group, distributed in order of birth and lactation stage, ensuring greater homogeneity among groups.

The cows were fed the same diet in collective trough, according to the local farm management. Roughage diets based on cactus and elephant grass were provided in collective trough twice a day, after the first milking, and after the second milking. During the interval between milkings, animals were kept in a grove-shaded area with free access to water.

Concentrate was given twice a day at a rate of 1 kg of feed for every 3 litters of milk produced per cow in individual troughs during milking, the ration was composed primarily of soybean meal, cottonseed meal, corn bran, wheat bran and minerals.

The waiting shed measured 3.0 m ceiling height, 8 feet wide and 6 feet long (48 m^2) with stone floor rejointed with cement paste, being these dimensions in accordance with EMBRAPA (2009), which recommends this area for 20 adult animals, with a density of 2.4 m^2 animal^{-1}. The covering was prepared with black mesh shade (70%), placed in single layer on a wooden structure without siding.

AECS composition had two axial Ventiave fans, P3D-Plus model, equipped with a three-phase motor of 0.5 HP AC with 1.0 m diameter, flow rate 240 m^3 min^{-1}, 965 RPM, and ability to produce air movement of up to 2.5 m s^{-1}, with 6 m spacing between devices, at 2.5 m elevated from the floor and tilted 20° from the vertical towards the floor.

The misting system was composed of five lines (½" polyethylene tube) with four nebulizing ASBRASIL nozzles per line, model HADAR 7110, with 1.5 m spacing between nozzles and between rows and elevated at 3.0 m height from the floor. This system was equipped with a Schneider® centrifugal pump, model BC-92SK, three phase motor of 0.75 HP, power consumption of 0.65 kWh and a flow rate of 240 L h^{-1}.

The AECS was connected to a power panel and triggered automatically by the controller, allowing the intermittent operation of the system when the animals were in the waiting shed. Fans and centrifugal pump were triggered when the temperature exceeded 26.0 °C and relative humidity below 65%, respectively.

To disable the system, a single-unit hysteresis was used, for both temperature and humidity, i.e., the driver turned off the fan and the centrifugal pump when the unit reached a temperature below 26.0 °C (25 °C) and relative humidity of 66%.

The power panel was composed of a three-phase circuit breaker (STECK® SD C10 3P 400V – 50/60Hz ~ IEC50889 3000A), a three-phase power meter (AAKER®), to measure electricity consumption, three jacks, two three-phase contactors (SIEMENS® 09A 220 3TF40-10 OXN18), being one to control the passage of the current to the fans and one for the centrifugal pump, as they were independently operated. In addition, the panel had two "on/off" keys to power the system manually, if necessary.

The controller was composed of a metal box 0.13 m wide, 0.25 m long and 0.06 m thick. Inside this box, boards were connected to each other forming an electronic circuit, and with other components (display, buttons, LEDs, on/off switch, fuse door to protect the equipment from large current variations and DB-type connectors, being that a DB 9 used for programming and a DB 25 received information from the sensors and another DB 25 passed information to the contactors).

The system was based on control of temperature and relative humidity by a semiconductor sensor (LM35), with variations of up to 0.75 °C within a temperature range between -55 °C and 150 °C, along with the monitoring of relative humidity (HIH-4004 series sensor, with variations of 0.5%, within the range of relative humidity from 0 to 100%). The LM35 sensor was properly protected and installed in the geometric center of the waiting shed and HIH-4004 sensor was installed in the external environment, to record the relative humidity and indicate the atmospheric evaporative demand, thus ensuring better efficiency of the AECS. This allowed determining the variables inside the facility as well its adjustment when necessary, by actuator activation. These sensors had low output impedance, linear voltage and inherent calibration, making the reading interface simple, and reducing the cost of the whole system.

Communication of sensors (LM35 and HIH-4004) with the controller was made through a sleeve-type cable connected to the appliance in a DB 15 entry. When the control received information, it processed and interpreted whether or not to connect or disconnect automatically some of actuators.

Meteorological variables were recorded in the waiting shed and external environment each minute through HOBO® Pro HB8 data loggers (Onset Computer Corporation Bourne, MA, USA) for recording of dry bulb temperature (DBT) and relative humidity (RH%).

For thermal efficiency of the AECS, together with the controller in the waiting shed, temperature and humidity index (THI) were determined, as proposed by THOM (1959).

Physiological parameters, rectal temperature (RT; °C), respiratory frequency (RF; mov min^{-1}) and coat temperature (TP; °C) were recorded in both milking shifts from 4.30 am to 5.10 am and from 1.30 pm to 2.10 pm, twice a week, before and after acclimatization.

RF recording was carried out by counting the number of movements performed in the flank of the animal, in a 1 min range. After RF registration, RT was measured with a veterinary digital thermometer ranging between 20 and 50 ^{o}C by inserting it into the animal rectum for 1 min, to allow stabilization and accurate temperature measurement.

CT was measured with an ETI Ltd® infrared thermometer with laser sight, model RayTemp™ 3. The average coat temperature was determined according to PINHEIRO et al. (2005), with temperature records of the head, back, shank and udder of each animal in each group, by using the following equation:

$$CT = 0.01\,T_{head} + 0.07\,T_{back} + 0.12\,T_{shank} + 0.08\,T_{udder} \tag{1}$$

Milk production (MP) was measured individually for each animal in its respective treatment, for both daily milking (morning and afternoon).

Technical and economic analyses enabled the determination of the feasibility of adopting the AECS associated with the controller, by quantifying the electricity consumption (kWh) for different time of acclimatization, equipment acquisition and installation. The average price paid to type-B milk producers commercialized in Pernambuco state rural region in the period of experiment was also considered in the calculations.

The fixed cost refers to the depreciation generated by the ratio between investment value and the useful life plus equipment maintenance cost, considering the exchange of nozzles, filters and sensors during a year, according to the manufacturer specifications. Variable costs considered were electricity and water expenses during the time the equipment (pump and fan) was on.

The experimental design was a 4 x 4 Latin square, considering 16 cows randomly distributed into four groups (G1, G2, G3 and G4) with four experimental periods (P1, P2, P3 and P4) and four treatments (control, 20, 30 and 40 min). For the analysis of variables (weather, comfort index, physiological and yield), the Statistical Analysis System software (SAS, 1992) was used, and the inferences obtained were evaluated by the Tukey's test (P <0.05).

RESULTS AND DISCUSSION

During the first milking (4.30 am to 5.10 am), the temperature and relative humidity remained within the zone of thermal comfort (ZTC) with air temperature between 4 and 26 °C, which is considered by PERISSINOTTO & MOURA (2007) suitable for the thermal comfort of dairy cows. The relative humidity remained above the proposed limit in the controller programming (65%). Thus, the misting system was not activated in the morning milking.

Table 1 shows that in the afternoon (1.30 pm to 2.10 pm) AECS was effective in reducing the ambient temperature, with differences (P <0.05) among all treatments, except between treatments 30 and 40 min, which the treatments 20 (0.1 °C), 30 (0.6 °C) and 40 min (0.9 °C) were below the upper critical temperature (26 °C) compared to the control, showing decreases of 4.0, 4.5 and 4.8 ^{o}C, respectively. Similar results were obtained by MATARAZZO et al. (2007) and ARCARO et al. (2006) that reached the ZTC during the pre-milking period by exposing the animals to AECS for 40 and 30 min, respectively.

The relative humidity recorded in the treatments with acclimatization increased significantly (P <0.05) with the automated AECS operating time, with treatments 20, 30 and 40 min above 70%, therefore, above the thermal comfort zone, between 50 and 70%, as recommended by SOUZA et al. (2007). Nevertheless, PERISSINOTTO & MOURA (2007) reported that when air temperature is near the ZTC upper limit (26 ^{o}C), regardless of the RH values, the thermal comfort feeling of dairy cows is considered very good, according to linguistic assignment defined by the authors in the intervals of temperature and humidity based on established rules of a fuzzy system.

The climate of the environment provided a significant reduction (P <0.05) for THI in the treatments 20, 30 and 40 min compared to the control, which was considered above the upper critical value (THI <75) for 7/8 Holstein-Gir cows in 3.6 units. The results presented in Table 1 are close to those observed by AZEVEDO et al. (2005) and ARCARO et al. (2006), who obtained THI 75.5 and 74.9 in the waiting shed, with exposure times to animal acclimatization of 40 and 30 min, respectively.

TABLE 1. Daily average values of environmental variables recorded during pre-milking, in the afternoon.

Variables	Treatments				
	Control	20	30	40	C.V. (%)
DBT (°C)	29.9 a±1.43	25.9 b±0.99	25.4 c±1.03	25.1 c±1.02	8.37
RH (%)	56.9 c±8.89	74.6 b±3.63	76.5 ab±3.53	77.8 a±3.70	14.13
THI	78.6 a±1.20	74.9 b±1.27	74.4 c±1.34	74.1 c±1.35	2.94

Means followed by the same letters in the same row do not differ at the level of 5% probability by the Tukey's test. DBT: dry bulb temperature; RH - relative humidity; THI - temperature-humidity index.

It can be seen in Table 2 that the averages for respiratory frequency (RF) showed no difference (P> 0.05) in the morning between treatments 20, 30, 40 and the control, with values around 43.5, 46.1, 45.0 and 42.5 mov min^{-1}, respectively. These RF values are considered normal, between 18 and 60 mov min^{-1}, according to MATARAZZO et al. (2007).

The average coat temperature (CT) was different (P <0.05) only between the control and 40 min treatments (30.1 and 29.8 °C). Rectal temperature (RT) remained within normal physiological values (38 to 39 °C), as suggested by PERISSINOTTO & MOURA (2007), and no significant differences (P> 0.05) were found among averages in control, 20, 30 and 40 min treatments, with values around 38.4, 38.4, 38.3 and 38.3 °C, respectively (Table 2).

In the morning production (Table 2), there is a difference (P <0.05) between treatments 20; 30 and 40 min compared with the control. The improvement compared with the control was approximately 0.381, 0.499 and 0.536 kg, corresponding to an increase of 3.09, 4.01 and 4.29% for the treatments 20; 30 and 40 min, respectively. These results are consistent with ALMEIDA et al. (2010) that found higher milk production in cows exposed to AECS for 30 min before the morning milking (11.437 kg day^{-1}) against (10.799 kg day^{-1}) for cows that received no acclimatization, confirming the beneficial effect of AECS. MATARAZZO et al. (2007) found an increase of 3.45% in daily milk yield in Holstein cows subjected to acclimatization in the waiting shed for 30 minutes, compared with cows that did not receive acclimatization in the waiting shed.

TABLE 2. Average values of physiological parameters evaluated in the different treatments in the morning.

Variables	Treatments (min)				
	Control	20	30	40	C.V. (%)
RF (mov min^{-1})	43.5 a±7.27	46.1 a±9.33	45.0 a±8.21	42.5 a±5.58	16.87
CT (°C)	30.1 a±0.83	30.0 ab±0.97	30.0 ab±0.61	29.8 b±0.81	2.62
RT (°C)	38.4 a±0.29	38.4 a±0.16	38.3 a±0.19	38.3 a±0.14	0.51
MP (kg)	11.94 b±1.12	12.32 a±0.78	12.44 a±0.84	12.48 a±0.69	7.21

Means followed by the same letters in the same row do not differ at the level of 5% probability by the Tukey's test. RF - respiratory frequency; CT - coat temperature; RT - rectum temperature; MP - milk production.

In the afternoon milking shift, difference was found in FR (P <0.05) only between 20 and 40 min treatments, however, there was a significant effect (P <0.05) when comparing treatments with acclimatization (20, 30 and 40 min) with the control, with values about 37.4, 36.5, 34.0 and 75.7 mov min^{-1}, respectively (Table 3). These results are consistent with studies by ALMEIDA et al. (2010), who also found a reduction in RF from 61.5 to 35.3 mov min^{-1} in Girolando lactating cows with access to a waiting shed equipped with AECS for about 30 minutes of exposure during the pre-milking period in the afternoon.

Mean TP values showed a significant reduction (P <0.05) in treatments 20; 30 and 40 min, being around 33.3, 32.6 and 32.0 °C, respectively, when compared with the control treatment, which showed 39.5 °C, and no significant effect among treatments with acclimatization (Table 3). The average values obtained in treatments 20; 30 and 40 min in the afternoon are close to the value of 32.5 °C obtained by PERISSINOTTO et al. (2006), for dairy cows subjected to acclimatization.

TABLE 3. Average values of physiological parameters evaluated in the different treatments in the afternoon.

Variables	Treatments (min)				
	Control	20	30	40	CV (%)
RF (mov min^{-1})	75.7 a±8.68	37.4 b±4.04	36.5 bc±3.38	34.0 c±2.45	39.73
CT (°C)	39.5 a±4.46	33.3 b±1.01	32.6 b±1.33	32.0 b±0.96	11.14
RT (°C)	39.4 a±0.31	39.3 a±0.36	39.1 b±0.36	39.0 b±0.25	0.87
MP (kg)	7.76 b±0.84	7.96 a±0.72	7.91 a±0.54	7.97 a±0.60	8.63

Means followed by the same letters in the same row do not differ at the level of 5% probability by the Tukey's test. RF - respiratory frequency; CT - coat temperature; RT - rectum temperature; MP - milk production.

The average RT values (Table 3) showed differences (P <0.05) between treatments 30 min (39.1 °C) and 40 min (39.0 °C) compared with the control (39.4 °C), a reduction of 0.3 °C and 0.4 °C, respectively. There was also an increase in the control, 20 and 30 min (0.4, 0.3 and 0.1 °C) treatments, respectively, within the limits considered normal for RT (38 to 39 °C). Similar results were obtained by PINHEIRO et al. (2005), who worked in the acclimatized waiting room with exposure of Jersey milk cows for 30 min (38.59 °C) and the control (39.11 °C), with a reduction of 0.52 °C.

According to ARCARO et al. (2006), the increase of rectal temperature shows that the heat release mechanisms became insufficient to maintain homoeothermy, but in the 40 min treatment, the RT remained within a normal range, indicating that the automated AECS was effective in maintaining the physiological responses of the animals to acclimatization to the climate inside the facility (Table 3).

Milk production in the afternoon shift (Table 3) showed differences (P <0.05) between treatments with acclimatization (20, 30 and 40 min) and the control treatment. The improvement in milk production was approximately 0.198, 0.155 and 0.214 kg, corresponding to an increase of 2.48, 1.96 and 2.68%, respectively, for treatments 20; 30 and 40 min. These results are consistent to those reported by BARBOSA et al. (2004), who found a significant difference in milk production from cows that received sprayed water before and after milking (7.04 kg) than cows that did not receive spraying (6.74 kg). There is, therefore, an increase in daily milk production in the order of 0.577, 0.652 and 0.748 kg cow^{-1} day^{-1}, with the addition of 2.85, 3.20 and 3.66% for 20; 30 and 40 min treatments, respectively. SOUZA et al. (2007) also obtained satisfactory results in the production of dairy cows under the effect of climate, arguing that knowledge of functional relationships between the animal and the environment facilitates the adoption of techniques to elevate production efficiency.

It can be seen in Table 4 that the initial investment by the automated design of AECS in the waiting shed was R$ 2,147.80, priced in January 2010. This survey was carried out taking into account the AECS use in January and February 2010.

TABLE 4. Investment and cost of facilities with nebulizers and fans.

Initial Investment	Quantity	Unit Value (R$)	Useful Life (years)	Total Value (R$)	Depreciation
Fans	2	450.00	15	900.00	60.00
Misting Nozzles	20	3.70	1	74.00	74.00
Water Pump	1	665.00	10	665.00	66.50
PVC Tubing	3	6.60	10	19.80	1.98
Polyethylene Tubing	35	0.40	10	14.00	1.40
Filter	1	45.00	1	45.00	45.00
Electric Material	1	250.00	20	250.00	12.50
Hydraulic Material	1	80.00	20	80.00	4.00
Labor	2	50.00	20	100.00	5.00
Sensor LM35	1	3.87	68	3.87	0.057
Sensor HIH-4004	2	29.45	16	59.00	3.68
Controller	1	493.39	-	493.39	-
Auxiliary Contactor	1	19.80	68	19.80	0.29
Sleeve-type Cable	10	4.35	-	43.50	-
Total R$				2767.36	274.41
Monthly Depreciation				22.87	

Considering that the area in the waiting shed was dimensioned for 20 animals, a projection was made for 120 animals, so the variable costs were based on the AECS time with four hours of daily operation, being this time needed to milk 120 cows, according to farm management.

For daily water consumption, considering four hours of operation with intermittent misting in the afternoon (1.30 pm to 5.30 pm), the variable monthly cost was R$ 56.16 (Table 5), accounting for 43.8% of variable cost reported by ALMEIDA et al. (2010) to operate an AECS for four hours without intermittence. The cost of the water used in the system was estimated at R$ 25.38 month^{-1}, corresponding to an average of R$ 3.00 m^{-3} of water, while spending on electricity for AECS system operation (pumping of the misting water in the system and ventilation) was from R$ 30.78 months^{-1}. ALMEIDA et al. (2010) found costs of R$ 86.40 and R$ 41.82 for the monthly consumption of water and energy, respectively, to operate the system.

TABLE 5. Variable cost.

Variable Cost	Quantity	Unit Value	Total Value
Water Consumption	1	25.38	25.38
Energy	1	30.78	30.78
Total R$ per month			56.16

The average daily milk production in control and 40 min treatments were 19.710 and 20.458 kg cow^{-1} day^{-1}, respectively (Tables 2 and 3), which generates variation of 0.748 kg milk cow^{-1} day^{-1}; by extrapolating to 120 lactating cows, totaling 89.76 kg day^{-1} per month, with 2,692.8 kg of milk as total farm production, with a monthly increase of R$ 1,992.67 (Table 6). ALMEIDA et al. (2010) found an increase of 0.765 kg milk cow^{-1} day^{-1} for the 30 min treatment, a monthly increase of R$ 1,266.84, considering 80 animals.

TABLE 6. Monetary value collected during a month.

Item	Value	Unity
Number of Animals	120	Unities
Increase in daily average production cow^{-1}	0.748	kg milk
Total of milk produced day $^{-1}$	89.76	kg milk day^{-1}
Total of milk produced month $^{-1}$	2,692.8	kg milk month^{-1}
Price of fresh milk	R$ 0.74	per kg milk
Monetary value per month	R$ 1,992.67	monthly

Table 7 brings the time for the return of the investment on the acclimatization system, knowing that the price of milk in the period from January to February was quoted at R$ 0.74, value received for the sale of milk during the month was R$ 1,992.67; by subtracting from this value, the variable costs and depreciation, it is obtained the actual profit of the farmer. Through the ratio between the initial investment cost and monetary value in days (profit), we found the time of return of the capital invested by the producer: 43 days. ALMEIDA et al. (2010) found that when using AECS in the pre-milking room for dairy cows, the estimated time of return on invested capital was 58 days.

Thus, it was observed in the present study, that the return of investment associated with the AECS paid off, indicating that the use of water to reduce heat stress in dairy cows is a viable alternative and therefore available to the farmer.

TABLE 7 - Return time of the investment.

	Monthly	Daily
Depreciation	22.87	0.76
Variable Cost	56.16	1.87
Milk Production	1,992.67	66.42
Farmer’s profit	1,913.64	63.79
Initial Investment	2,767.36	
Total of days for investment return	43 days	

CONCLUSIONS

Exposure of animals to 40 min acclimatization allowed better thermal environment with lower values for physiological variables: rectal temperature, respiratory frequency and coat temperature, which promoted an increase of 3.66% in milk production.

Investment in AECS in the waiting shed for lactating dairy cows was satisfactory and profitable, with a return time of the invested capital of 43 days.

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