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**POSTER**

# Lactation curve of cross-bred buffalo under two production systems in the Amazonian region of Brazil

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**ABSTRACT:** This study was conducted at the Agroforestry Research Center of EMBRAPA (CPAFRO), Rondônia, Brazil, to evaluate the lactation curve of crosss-bred buffalo [Murrah (M), Mediterranean (Me) and Jafarabadi(J)] under two production systems. Production system one (PS1) corresponded to the period of 1984 to 1998 where animals (4471 observation) were milked once a day and received only pasture without supplementation. Production system two (PS2) corresponded to the period of 1999 to 2002 where animals (458 observations) were milked twice daily with concentrate supplementation to pasture. Eight mathematical functions were used: Inverse Polynomial, Linear Hyperbolic, Incomplete Gamma, Logarithmic, Logarithmic Quadratic, Linear, Quadratic and Jenkins & Ferrel. Statistical analysis was conducted using PROC NLIN of SAS (2005). Results showed that for both production systems, Incomplete Gama was the best function to describe the lactation curve. Values of coefficient of determination, standard-deviation, coefficient of variation and standard-error were 95%, 0.068, 7.20, and 0.003, respectively. The corresponding values for PS2 were 96%, 0.200, 2.12, and 0.003. Values of the lactation curve parameters (a, b, and c) for PS1 and PS2, respectively, were (a) 7.0035923 and 10.9209, (b) -0.1080043 and -0.1614882, (c) 0.0434868 and 0.0679365.

**Key words**: Amazonian, Buffalos, Coefficient of determination, Incomplete gamma function.

**INTRODUCTION -** The state of Rondônia is located in the Amazonian region of Brazil. Milk production is considered an important source of income for many farmers in the region due to pasture availability. The milk productivity per cow in Rondônia is low for several reasons which include genetic factors, exclusive use of pasture, poor quality pasture during dry season and lack of proper veterinary services. The low-input, extensive system of milk production in Rondônia has resulted in pasture deterioration and abandonment of land by farmers. Buffalo was introduced in Brazil more than 100 years ago, from the island of Marajó, in the state of Pará. The buffalo population spread throughout the Amazonian region where more than 60% of the total Brazilian buffalo population is located (Ramos 2003;). The total buffalo population in Brazil is estimated at 1.15 million animals distributed through all regions of the country (IBGE, 2006). The lactation curve is a graphical representation of the of milk production throughout lactation. The determination of the lactation curve by using statistical models is an useful tool to predict milk yield at any time throghout the lactation period. This technique can facilitate the decision of the producer in selecting more productive and culling low producing animals as well as introducing new genetic materials. The objective of this trial was to identify the best mathematical model to describe the lactation curve in test day of cross- bred Buffalo in Brazil.

**MATERIAL AND METHODS** - The study was conducted in the Center of Agroflorestal Research of the Embrapa of Rondônia (CPAFRO/EMBRAPA), located in the city of Porto Velho, Brazil. Two production systems were evaluated from 1984 to 2002. Production system 1 (PS1) corresponded to the period from 1984 to 1998 with 4471 observations. Production system 2 (PS2) corresponded to the period from 1999 to 2002, when 458 with observations. Three breeds of buffalo (Murrah, Mediterranean and Jafarabadi) of various genetic groups were evaluated. The State of Rondônia has a tropical climate with high annual precipitation (2000 mm/year) and moderate dry period between June and September. The average temperatures are between 24 and 26°C and the average relative humidity ranges between 80 and 90%. The annual day light and evaporation were 1770 hours and more of 750 mm, respectively. In SP1, animals were raised on pasture under extensive management system. The pasture included *Brachiaria humidicola*, *Andropogon gayanus*, *Brachiaria brizantha* (cv. Marandu) and *Pueraria phaseoloides*. During the dry season animals grazed on *Pennisetum purpureum*. Animals were handmilked once daily. Milk yield was recorded once a month. Calves remained with their mothers until weaning (6 to 7 month of age). The culling rate of adult females was of 10% for year. A natural breeding system was used with one bull every 40 cows. Females weighing 450 kg or more were considered suitable for reproduction. Cows remained with bulls for two months before they were moved to maternity pens. Veterinary care included vaccination and control of endo and exo-parasites. In PS2, a new technology for milk production was introduced. Calves were separated from their mothers at birth and received two liters of milk per day twice daily for 90 days. Cows were supplemented with a concentrate diet consisted of 60% corn and 40% of rice bran at the level of one kg of concentrate per 3 kg of milk produced. Supplementation was ceased when production dropped below 3 kg per day. The grazing system was similar to that of PS1. Animals were milked one daily with animals producing more than 6 kg per day being milked twice. Culling rate and health care were similar to those in SP1. The following regression models were used to fit the milk production data to lactation curves (Alencar *et al*. 1995 and Gonçalves *et al*. 1996): Linear: $Y = \beta_0 + \beta_1$ Time + $\varepsilon$; Quadratic: $Y = \beta_0 + \beta_1$ Time + $\beta_2$ Time$^2$ + $\varepsilon$; Logarithmic linear: $Y = \beta_0 + \beta_1$ Time + $\beta_2 \log_e$ (Time) + $\varepsilon$; Logarithmic quadratic: $Y = \beta_0 + \beta_1$ Time + $\beta_2$ Time$^2$ + $\beta_3 \log_e$ (Time$^2$) + $\varepsilon$; Incomplete gama: $Y = \beta_0$ Time$^{\beta_1}$ * exp(-$\beta_2$ Time) + $\varepsilon$; Linear hyperbolic: $Y = \beta_0 + \beta_1$ Time + $\beta_2$ / Time + $\varepsilon$; Inverse polynomial: Y = Time / ($\beta_0 + \beta_1$ Time + $\beta_2$ Time$^2$) + $\varepsilon$; Jenkins and Ferrell: $Y = \beta_0$ / ((Time * exp ($\beta_1$ Time)) + $\varepsilon$. Parameters of the lactation curve were estimated using Marquardt method of PROC NLIN (SAS, 2005). The model yielded the highest coefficient of determination was chosen as the best model to describe the lactation curve.

**RESULTS AND CONCLUSIONS -** Table 1 shows values for coefficient of determination for the various models used to describe the lactation curve of buffalo under PS1 and PS2. Incomplete Gamma (IG) was that generated the highest coefficient of determination ($R^2$ = 0.95, for PS1 and $R^2$ = 0.96, for PS2) followed by Jenkins and Ferrel model ($R^2$ = 0.85, for SP1 and $R^2$ = 0.88, for SP2). Lactation curve parameters according the Incomplete Gamma model for buffalo under PS1 and PS2 are shown in Table 2. Figure 1 shows daily milk production in SP1 and SP2. The IG function must have a lactation peak, but it is not true in the current study. The lack of a lactation peak is likely due to the low level of nutrition of buffalo under the two production systems. Despite the high determination coefficient, the IG function overestimated the lactation curve of buffaloes, creating an asymptote after the curve inflection.

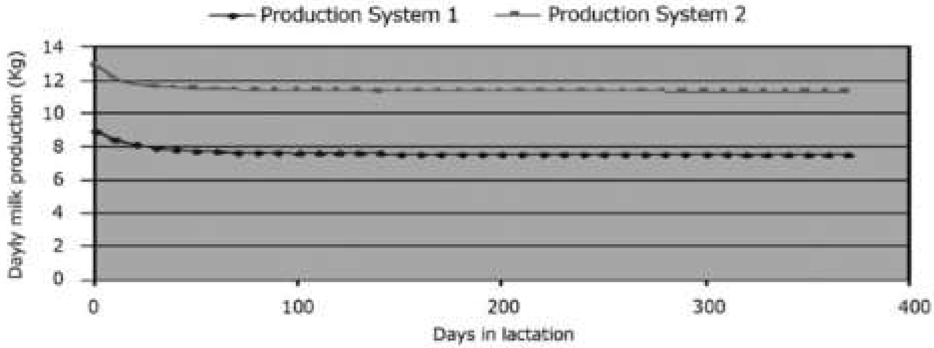
Table. 1. Coefficient of determinations for the various models used to describe the lactation curve in buffalo under two production systems (EMBAPRA-CPAFRO).

| Function | PS | $R^2$ | sd | CV | se | CI lower | CI upper |
|---|---|---|---|---|---|---|---|
| Incomplete gamma | 1 | 0.95 | 0.07 | 7.22 | 0.0035 | 0.9435 | 0.9564 |
| | 2 | 0.96 | 0.02 | 2.12 | 0.0030 | 0.9546 | 0.9669 |
| Linear hyperbolic | 1 | 0.62 | 0.25 | 41.24 | 0.0153 | 0.5881 | 0.6482 |
| | 2 | 0.59 | 0.37 | 62.71 | 0.0703 | 0.4488 | 0.7373 |
| Jenkins & Ferrel | 1 | 0.85 | 0.09 | 10.96 | 0.0045 | 0.8457 | 0.8635 |
| | 2 | 0.88 | 0.08 | 9.25 | 0.0122 | 0.8600 | 0.9092 |
| Logarithmic linear | 1 | 0.59 | 0.26 | 44.27 | 0.0126 | 0.5668 | 0.6164 |
| | 2 | 0.54 | 0.26 | 49.31 | 0.0398 | 0.4552 | 0.6157 |
| Inverse polynomial | 1 | 0.62 | 0.25 | 41.24 | 0.0153 | 0.5881 | 0.6482 |
| | 2 | 0.59 | 0.37 | 62.71 | 0.0703 | 0.4488 | 0.7373 |
| Logarithmic quadratic | 1 | 0.69 | 0.24 | 34.04 | 0.0114 | 0.6724 | 0.7171 |
| | 2 | 0.60 | 0.26 | 42.98 | 0.0389 | 0.5218 | 0.6787 |
| Linear | 1 | 0.40 | 0.29 | 71.62 | 0.0140 | 0.3783 | 0.4332 |
| | 2 | 0.37 | 0.27 | 74.28 | 0.0410 | 0.2875 | 0.4528 |
| Quadratic | 1 | 0.58 | 0.27 | 46.43 | 0.0129 | 0.5541 | 0.6049 |
| | 2 | 0.50 | 0.29 | 57.41 | 0.0426 | 0.4121 | 0.5839 |

Table. 2. Parameters of the incomplete gamma model for production systems (EMBRAPA-CPAFRO).

| Parameters | N | PS | Minimum | Maximum | Average | sd | CV | se | IC Lower | IC Upper |
|---|---|---|---|---|---|---|---|---|---|---|
| a ($\beta_0$) | 117 | SP1 | 0.2543 | 694.302 | 70.035 | 88.729 | 126.6 | 0.8203 | 53.788 | 86.283 |
| a ($\beta_0$) | 17 | SP2 | 0.9451 | 468.689 | 109.209 | 102.795 | 94.1 | 24.931 | 56.356 | 162.061 |
| b ($\beta_1$) | 117 | SP1 | -0.6802 | 0.5859 | -0.1080 | 0.2323 | -215.1 | 0.0214 | -0.1505 | 0.0654 |
| b ($\beta_1$) | 17 | SP2 | -0.5763 | 0.2191 | -0.1614 | 0.1927 | -119.3 | 0.0467 | -0.2605 | 0.0623 |
| c ($\beta_2$) | 117 | SP1 | -0.0061 | 0.2768 | 0.0434 | 0.0462 | 106.3 | 0.0042 | 0.0350 | 0.0519 |
| c ($\beta_2$) | 17 | SP2 | -0.0063 | 0.5378 | 0.0679 | 0.1256 | 184.9 | 0.0304 | 0.0033 | 0.1325 |

Figure 1. Lactation curves estimated by incomplete Gamma function in two production systems.

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