IMPACTS OF TWO CLIMATE CHANGE SCENARIOS ON THE REGIONAL VARIATION OF THE DECLINE IN MILK PRODUCTION IN THE PERNAMBUCO STATE, BRASIL

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ABSTRACT

The optimist (B1) and pessimist (A1F1) scenarios of the Intergovernmental Panel on Climate Change (IPCC) were used to study the effects of the global warming on the monthly air relative humidity (RH_m) and to evaluate their impact on the regional variation of Milk Production Decline (MPD) for cows presenting Milk Production Levels (MPL) 10, 20 and 30 kg $cow^{-1}day^{-1}$.

The effects on the RH_m were estimated by using a model reported on the literature that presents great statistical performance and physical consistence. It was observed expressive alterations in the main milk producing regions (Garanhuns, Valleys of Ipanema and Ipojuca).

Thus, the elaboration of public politics aiming to mitigate the effects on the dairy husbandry of the Pernambuco State is of great importance.

KEYWORDS. Dairy husbandry, milk production level, global warming, mapping

INTRODUCTION

According to the Intergovernmental Panel on Climate Change (IPCC) report, most of the climate specialists have no doubts that the planet is getting warm. It was suggested that the

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climate changes are caused by increasing on gases emission such as carbonic, methane and nitrous oxide (IPCC, 2007).

Those changes can intensify the heat stress in cows by modifying the processes of heat transference between animals and the environment (Sirohi & Michaelowa, 2007). Alteration on these processes may promote reduction on animal feed uptake, reproduction, lactation and production (García-Ispierto et al., 2006; Hahn, 1999; West et al., 2003).

The animal productive performance can be estimated by quantifying the Milk Production Decline (MPD) (Zolnier et al., 1993), which allows accomplishing studies on regional scale (Turco et al., 2006) by using normal climate data (Brown-Brandl et al., 2005).

The impacts of the climate changes on the agroclimatological zoning have been evaluated (Assad et al., 2006; Marin et al., 2007). However, just a few of them are about dairy husbandry (Jones & Hennessy, 2000).

One difficulty to evaluate the impacts of the global warming on dairy husbandry is the lack of information on variation of the monthly relative humidity, because the IPCC is associated just on the effects of temperature and precipitation. Thus, to accomplish more detailed data, the model developed by Silva et al. (2007a) has been shown of great statistical performance and physical consistence, and it has been used to evaluate the effects of climate changes on the monthly relative humidity (ΔRH_m).

The State of Pernambuco is the second milk producer of the Northeast Region and it is responsible for 18.1% of the milk production (IBGE, 2008).

Thus, this work aimed to determinate the impacts of the scenarios B1 (most optimistic) and A1F1 (most pessimistic) of climate changes on the regional variation of the milk production of the Pernambuco State.

METHODOLOGY

Air temperature (t_m, ^oC) and air relative humidity (RH_m, %) data were used to calculate the Temperature-Humidity Index (THI) as follows (Thom, 1959):

$$THI = t_m + 0.36t_{pr} + 41.2 \quad (1)$$

where, t_{pr} is the dew point temperature (ºC), calculated by using psychometric equation as function of the values of the RH_m (Vianello & Alves, 2000).

The t_m and RH_m data were obtained from eight weather stations and calculated for 244 pluviometric stations that haven't these data. The calculated t_m values were obtained by using

models proposed by Cavalcanti & Silva (1994). It considers the geographical data such as latitude, longitude and elevation. These t_m values and the monthly precipitation data together were used to calculate the RH_m values using the model cited by Silva et al. (2007a). It was also used to estimate the variation of the RH_m data (ΔRH_m) due the climate changes. The general model can be expressed as follows:

$$RH_m = a \exp\left\{-\exp\left[\frac{-(Im - b)}{c}\right]\right\}. [d + e(t_m \lambda)] \quad (2)$$

The a, b, c, d and e coefficients were regionally adjusted by Silva et al. (2007b) for the Pernambuco State, where a= 87.0982; b= -141.6209, c= 65.3662, d= 1.3524 and e= 0.0003974. λ is the longitude of the 244 pluviometric stations. I_m is the effective moisture index that is function of the monthly precipitation (P_m) and evapotranspiration data ($I_m = [P_m / ETP_m] \times 100$). ETP_m is function of the t_m.

Monthly mean Milk Production Decline data (MPD) were calculated by using the following equation proposed by Berry et al. (1964):

$$MPD = -1.075 - 1.736\,MPL + 0.02474\,MPL\,THI \quad (3)$$

where, MPD, in kg $cow^{-1}day^{-1}$; MPL is the milk production level, kg of milk $cow^{-1}day^{-1}$. The MPL values of adopted were 10, 20 and 30 kg of milk $cow^{-1}day^{-1}$.

To evaluate the impacts of the climate change on the MPD, the B1 and A1F1 scenarios cited by the IPCC (2007) were used. The B1 and A1F1 scenarios considered increases of 1.8°C and 4.0°C, respectively, in the global mean temperature (Δt_m).

The impacts of the climate change on the RH_m were estimated by adding 1.8°C and 4.0°C in the t_m used on the equation 2.

The effect of the scenarios of the possible climate changes on the air relative humidity variation (ΔRH_m) was obtained from subtraction of the current RH_m ($RH_{m\ current}$) values from the RH_m values for the future scenarios ($RH_{m\ scenarios}$).

The Δt_m and ΔRH_m values were added to the current t_m and RH_m data obtained from 252 stations to calculate THI (equation 1), including the climate change scenarios. Then, the data of THI were used to calculate MPD, also, for B1 and A1F1 scenarios. The IPCC scenarios for precipitation were not considered in this work due the uncertainties of estimative mentioned by the IPCC (2007).

The variability of the MPD values for the current, B1 and A1F1 scenarios for Pernambuco

State was analyzed using isoline maps of the MPD for the Summer season. These maps were obtained by interpolation using the krigging technique and spherical model used previously by Silva et al. (2007a).

RESULTS AND DISCUSSION

It was observed that the possible increase of 1.8^{o}C (B1 scenario) and 4.0^{o}C (A1F1 scenario) resulted, respectively, in a variation around -3.5±0.79% and -7.9±1.90% of the monthly values of air relative humidity ($\Delta RH_{m\ med}$) for Pernambuco State estimated by the Silva's model.

The using of the model proposed by Silva et al. (2007a) resulted in consistent data for variations in the t_m and the P_m.

The values of Δt_m and ΔRH_m were used in the B1 and A1F1 scenarios to estimate the MPD in the summer season and to obtain its maps (Figure 1).

For the current scenario (Figure 1A, 1D and 1G), the semi-arid and coastal areas in the Pernambuco State presented higher MPD values (1.75 and 3.5 kg of milk cow^{-1}day^{-1}, respectively) with MPL around 30 kg of milk cow^{-1}day^{-1}.

Currently, the Pernambuco State presents an extensive favorable area for cows with low productive level (10 kg of milk cow^{-1}day^{-1}) (Figure 1A).

For the B1 scenario (Figure 1B, 1F and, 1H) there was an increasing of the areas with reduction in the milk production and also for cows least productive (10 kg of milk cow-1day-1) (Figure 1B). For cows with higher production levels (20 and 30 kg of milk cow-1day-1) it was possible to observe that good areas for dairy husbandry are located in the central region of the State, where is located the main region of milk production (Garanhuns, Valleys of Ipanema and Ipojuca) (IBGE, 2008).

The higher values of MPD for cows with 20 kg of milk cow^{-1}day^{-1} varied between 3.5 and 5.25 kg of milk cow^{-1}day^{-1} and represented the major area of the State (Figure 1F) for the A1F1 scenario.

For cows presenting 30 kg of milk cow^{-1}day^{-1}, the values of MPD varied between 3.5 to 5.25 kg of milk cow^{-1}day^{-1} in the semi-arid and coastal areas for the pessimist scenario (Figure 1G).

The smallest values of MPD for cows with that production level were verified in the central region of the State, where the values reached 1.75 kg of milk cow^{-1}day^{-1}.

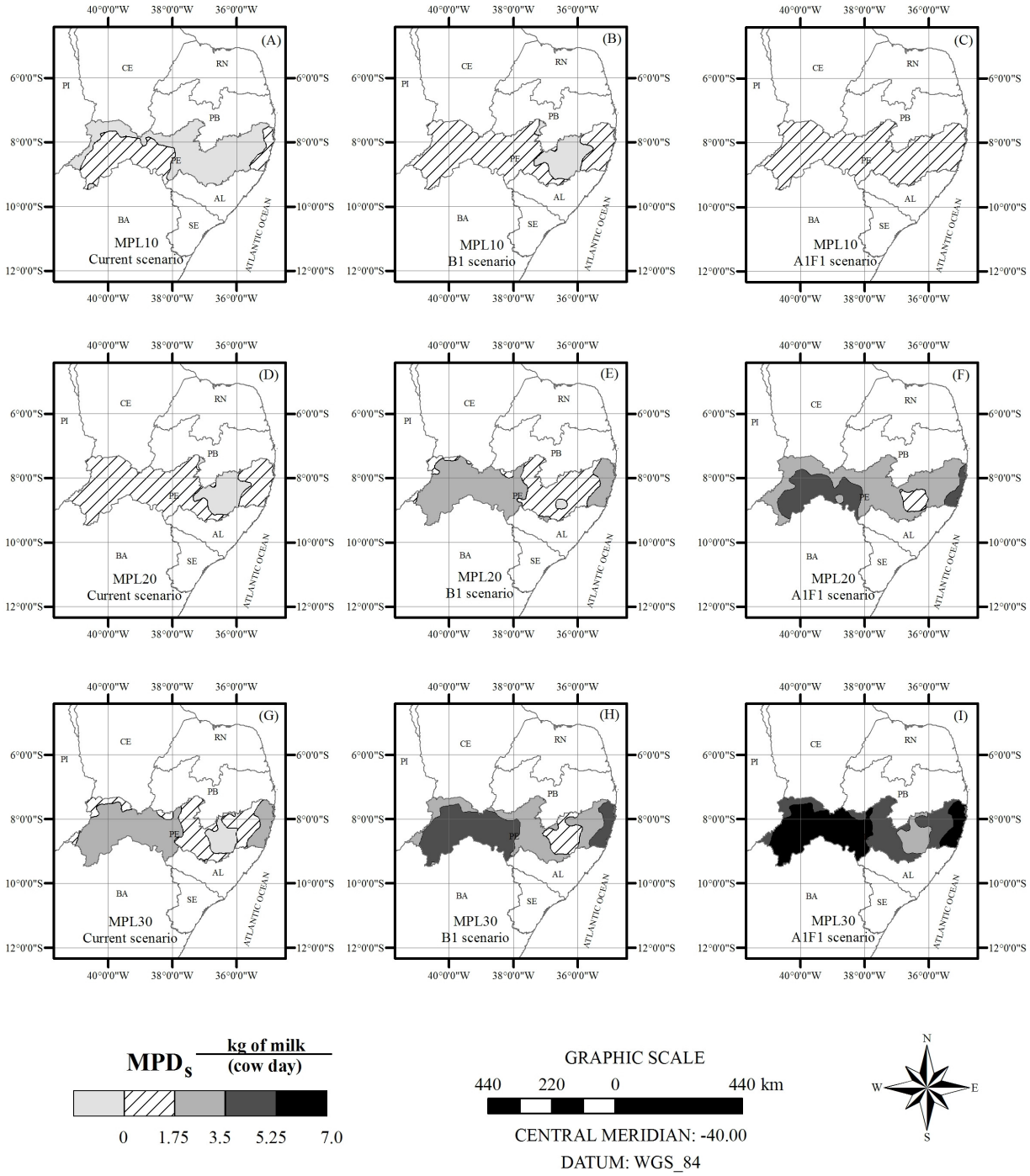

Figure 1. Regional variability of the Milk Production Decline during the Summer season (MPDs) for cows with Milk Production Level (MPL) of 10 kg of milk cow^{-1} day^{-1} (A, B and C), 20 kg of milk cow^{-1} day^{-1} (D, E and, F) and 30 kg of milk cow^{-1} day^{-1} (G, H and I) in Pernambuco State for current (A, D, G), B1 (B, E, H) and A1F1 (C, F, I) scenarios.

The largest losses of milk production were observed for A1F1 scenario, where the values of MPD reached 7.0 kg of milk $cow^{-1}day^{-1}$ for cows with 30 kg of milk $cow^{-1}day^{-1}$.

The better areas for dairy husbandry (null MPD) were found only for cows with 10 kg of milk $cow^{-1}day^{-1}$ in areas placed in the main regions of milk productions of the State.

CONCLUSION

The possible global warming can promote expressive losses on the milk production, besides in the regions of Garanhuns, Valleys of Ipanema and Ipojuca, where are located the higher producing region, suggesting the necessity of elaborating public politics with objective of mitigating the effects on the dairy husbandry of the Pernambuco State.

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