



Impact of climate change on the dairy industry in temperate zones: Predications on the overall negative impact and on the positive role of dairy goats in adaptation to earth warming



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ABSTRACT

The environment within which domesticated livestock production, agricultural crops and related management practices developed over the past 10,000 years is rapidly changing due to human-induced climate change (CC). Nowadays, even countries located within the temperate zone are affected by changes in global warming. These changes are associated with unprecedented events of extreme high ambient temperature (above 40 °C) and seasonal changes. The number of days with temperature humidity index (THI) above a specific comfort threshold (>68) has noticeably increased in recent years in European countries located within the temperate zone. The rate of global warming, including in the temperate zone, is expected to continue to vulnerable in coming years. Agricultural production from crops and livestock, and thus global food security, is already affected by CC and will continue to be influenced by global warming. Thus, these changes will continue to affect the dairy industry directly and indirectly. The most significant indirect effect is expected to result from cruel reduction in worldwide grains (concentrate feedstuffs) production. This change will impose need to tradeoff between the diminished food sources: using higher proportions of grains production for human nutrition, instead of feeding it to livestock. Similar conflict is expected to be relevant in using high-quality forages that can be used as edible food for humans. Heat stress imposed by high ambient temperature in temperate zones, such as in Germany, northern Italy and the US was identified in recent years as a major factor that affect negatively milk production, reproduction, and the health of dairy cows. Heat stress also has shown to increase appreciably cow's mortality in those areas. On the other hand, there is no evidence that dairy goat production in temperate zones is affected so far; though, evidence for such an effect was notice in desert and Mediterranean (e.g., Turkey) countries. The major aim of this critical review is to analyze the literature in order to predict how the current trend in harshening of the impact of climatic changes affect dairy industry and to forecast how CC will affect the dairy cows and goat industry in countries located within the temperate zone? Particularly, the direct effects of heat stress on milk production are emphasized. Among domestic ruminants, goats are the most adapted species to imposed heat stress in terms of production, reproduction and resistance to diseases. The main conclusion that can be made is that uttermost scenarios of climatic change will negatively affect the dairy industry and that the importance of goats to the dairy industry will increase in proportion to the severances of changes in environmental temperature.

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1. Introduction

Weather patterns on a global basis have changed noticeably over the past several decades (IPCC, 2007). These climatic changes are not restricted to tropical, arid or Mediterranean zones. Weather patterns in central and northern European (EEA-JRC73 WHO, 2008) and US (Adams et al., 1990) regions have changed noticeably over the past several decades, and are characterized by more extreme events and seasonal changes such as, warmer summers and wetter and longer rainy season. It is widely predicted that warming will continue for centuries and will be associated in central-northern Europe and North America with more frequent heat waves during summers and heavy rainfall during winters. This trajectory is a foreseeable future, even under the most modest warming scenarios and thus most likely will have a significant impact on livestock farming.

The effect climatic change (CC) on dairy production are both direct through effects on the animals themselves, and indirectly through effects on production of crops and increased exposure to pests and pathogens (Gauly et al., 2013). These negative impacts occur in face of increasing demands for food, which is related to increase in population on earth (Godfray and Garnett, 2014). The demand for animal products relate to rapid increase in income in some countries (Haq and Ishaq, 2011), particularly in China (Qian et al., 2011), and the perception of dairy products as high quality and gourmet food (Silanikove et al., 2010). On the other hand, there is an increased awareness to the contribution of livestock to the greenhouse effect (EPA, 2011; Steinfeld et al., 2006), and hence to global warming. Thus, development of adaptation strategies aimed at taking advantage of new opportunities and/or minimizing the negative impacts of CC are needed in order to maintain food supply security (e.g., Knapp et al., 2014). Some climatologists consider that deliberated reduction of meat and dairy production would be an important adaptive strategy for European countries (Westhoek et al., 2014).

In this review, the potential implications of earth warming on dairy cows and dairy goat production in temperate climatic zones, such as, central-northern Europe are considered. An effort will be made to evaluate the direct and indirect effects of CC on productivity and to predict how CC will affect dairy animal's production system and how dairy goat farming would fit in those changes. Finally, some suggestions for future research priorities, which will allow predicting the effect of CC and to adjusting to CC, are made. The main conclusions that reached is that farthest scenarios of CC will negatively affect the dairy industry and that the importance of goats to the dairy industry will increase in proportion to the severances of changes in environmental temperature.

2. A short overview on the relative sizes of the global dairy cows and goat industries

While most countries produce their own milk products, the structure of the dairy industry varies in different parts of the world. The share of total dietary energy intake coming from dairy products is around 14% in developed and only 4% in developing countries (Gerosa and Skoet,

2012). Developing country growth in demand for milk and consumption of milk has been matched by population size and is quite constant. In developing countries, the production growth has significantly outpaced that of developed countries, particularly in countries with increase of income.

Cow milk dominates global milk production, but milk from other animals is important in specific regions, countries and local contexts, particularly for family type production systems in developing regions. Globally, cow milk represents 85% of world production and at least 80% of total production in all regions except South Asia, where its share is less than half (44%). Geographically, around 34% of the total milk production from cows is located in countries with temperate environment and/or in countries having the ability to invest on technologies for mitigating heat stress: USA, 10%, Europe, 14% and Russia and former USSR countries, 10%. In addition to cow milk, only buffalo milk makes a substantial contribution at the global level accounting for 11% of global production and 23% of developing countries production. The contribution of milk from goats (3.4%), sheep (1.4%) and camels (0.2%) is much lower (Gerosa and Skoet, 2012).

However, the low proportion of the contribution of the dairy goat sector to total milk production is misleading. About 80% of the goats around the world are located in tropical areas of Asia and Africa. As the proportion of cows in those areas is the lowest and as most human population lives in these areas, it is most probable that more people in the world drink milk or consume dairy products from goats than from any other animal (Silanikove et al., 2010). Moreover, productions of milk by goats have risen during the last 20 years. The increase occurred not only in countries with low income (75%), but also in those with high (20%) or intermediate (25%) income (Gerosa and Skoet, 2012). It was recently concluded that goat will continue to have an important role in harsh conditions, tropical, sub-tropical, desert and Mediterranean environments (Koluman and Silanikove, 2014). In the rest of this review we will try to analyze the reasons for this trend and predict how CC will affect future dairy cows and goat production in temperate zones.

3. The main factors that are expected to affect dairy production under global warming

Climate change impacts on crop (Adams et al., 1990; Hatfield et al., 2011; Lobell et al., 2011) and livestock (Koluman and Silanikove, 2014) production are already being witnessed all over the world. According to the Fourth Assessment Report of the Intergovernmental Panel on CC (IPCC, 2007), the forecasted CC and extreme events are expected to have a dramatic impact on natural ecosystems and economy in many parts of the world, including in those considered so far as temperate zones (IPCC, 2007). Climatologists forecast that temperatures across Europe will rise over the coming decades and that the frequency of periods of extremely high temperatures will double, whereas the winter will be rainier and will be associated with floods (Solymosi et al., 2010; Tobias et al., 2013).

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