IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Impact Factor: 7.301

Volume 3, Issue 2, November 2023

Assessing the Effects of Climate Change on Dairy Cow Production Systems: A Review of Emerging Challenges

Virendra Kumar Prajapati[1] and Dr. Narendra Singh Gurjar[2]

Research Scholar, Department of Agricultural[1]

Research Guide, Department of Agricultural[2]

Sunrise University, Alwar, Rajasthan, India

Abstract: *We refer to planetary-scale changes as "global changes." This general term covers a wide range of subjects, including the use of resources, the development of energy, population growth, land use and cover, the carbon and nitrogen cycles, pollution and health, and climate change. The challenges that climate change, one facet of global change, poses to Europe's dairy cow production systems are covered in the article. Accelerated global warming threatens ecosystems, biodiversity of plants and animals, and the security and safety of food supplies. It is generally established that the direct and indirect effects of global warming, when coupled with an increase in the frequency of weather extremes, constitute a serious danger to cattle production, even in areas with moderate climates like Central Europe. We will discuss potential and observed consequences of climate change, including increased temperatures, more frequent hot days, and heat waves. We'll concentrate on the challenges confronting grassland production, the standard of fodder, overall nutrition, health and wellbeing of cows, and the efficiency of dairy production. Both direct and indirect effects are linked to animal performance. There are strong indications that when an animal is chosen for high-yielding features, its susceptibility to climate change increases. Cumulative effects (e.g., higher temperature with rising loads of diseases and their vectors) amplify these impacts. To address the consequences, many possible adaptation and mitigation strategies need to be developed on several levels. Breeding plan adjustments, health care management, and production system (housing, feeding, and management) adjustments are included in this*

Keywords: Heat stress, Feed quality and availability, Disease outbreaks

REFERENCES

[1]. Aguilar I, Misztal I and Tsuruta S 2009. Genetic components of heat stress for dairy cattle with multiple lactations. Journal of Dairy Science 92, 5702–5711. https://doi.org//10.3168/jds.2008-1928

[2]. Akbarabadi MA, Shabankareh HK, Abdolmohammadi A and Shahsavari MH 2014. Effect of PGF2α and GnRH on the reproductive performance of postpartum dairy cows subjected to synchronization of ovulation and timed artificial insemi- nation during the warm or cold periods of the year. Theriogenology 82, 509–516. https://doi.org//10.1016/j.theriogenology.2014.05.005

[3]. Al-Kanaan A, König S and Brügemann K 2015. Effects of heat stress on semen characteristics of Holstein bulls estimated on a continuous phenotypic and genetic scale. Livestock Science 177, 15–24.

[4]. Allen JD, Hall LW, Collier RJ and Smith JF 2015. Effect of core body temperature, time of day, and climate conditions on behavioral patterns of lactating dairy cows experiencing mild to moderate heat stress. Journal of Dairy Science 98, 118–127. https://doi.org//10.3168/jds.2013-7704

[5]. Ammer S, Lambertz C and Gauly M 2016. Comparison of different measuring methods for body temperature in lactating cows under different climatic condi- tions. Journal of Dairy Research 83, 165–172.

[6]. Ammer S, Lambertz C, von Soosten D, Zimmer K, Meyer U, Dänicke S and Gauly M 2017. Impact of diet composition and temperature–humidity index on water and dry matter intake of high-yielding dairy cows. Journal of Animal Physiology and Animal Nutrition 102, 103–113.

[7]. Anzures-Olvera F, Véliz FG, Santiago A de, García JE, Mellado J, Macías-Cruz U, Avendan˜ o-Reyes L and Mellado M 2019. The impact of hair coat color on physio- logical variables, reproductive performance and milk yield of Holstein cows in a hot environment. Journal of Thermal Biology 81, 82–88. https://doi.org//10. 1016/j.jtherbio.2019.02.020

[8]. Avendan˜ o-Reyes L, Álvarez-Valenzuela FD, Correa-Caldero´ n A, Algándar- Sandoval A, Rodríguez-González E, Pérez-Velázquez R, Macías-Cruz U, Díaz-Molina R, Robinson PH and Fadel JG,2010. Comparison of three cooling management systems to reduce heat stress in lactating Holstein cows during hot and dry ambient conditions. Livestock Science 132, 48–52. https://doi.

[9]. org//10.1016/j.livsci.2010.04.020

[10]. Berman A 2011. Invited review: are adaptations present to support dairy cattle productivity in warm climates? Journal of Dairy Science 94, 2147–2158. https:// doi.org//10.3168/jds.2010-3962

[11]. Berman A, Horovitz T, Kaim M and Gacitua H 2016. A comparison of THI indices leads to a sensible heat-based heat stress index for shaded cattle that aligns tempera- ture and humidity stress. International Journal of Biometeorology 60, 1453–1462.

[12]. Bernabucci U, Biffani S, Buggiotti L, Vitali A, Lacetera N and Nardone A 2014. The effects of heat stress in Italian Holstein dairy cattle. Journal of Dairy Science 97, 471–486. https://doi.org//10.3168/jds.2013-6611

[13]. Bett B, Kiunga P, Gachohi J, Sindato C, Mbotha D, Robinson T, Lindahl J and Grace D 2017. Effects of climate change on the occurrence and distribution of livestock diseases. Preventive Veterinary Medicine 137, 119–129. https:// doi.org//10.1016/j.prevetmed.2016.11.019

[14]. Bohmanova J, Misztal I, Tsuruta S, Norman HD and Lawlor TJ 2008. Short com- munication: genotype by environment interaction due to heat stress. Journal of Dairy Science 91, 840–846.

[15]. Bouraoui R, Lahmar M, Majdoub A, Djemali M and Belyea R 2002. The relation- ship of temperature-humidity index with milk production of dairy cows in a Mediterranean climate. Animal Research 51, 479–491.

[16]. Buffington DE, Collazo-Arocho A, Canton GH, Pitt D, Thatcher W and Collier RJ 1981. Black globe-humidity index (BGHI) as comfort equation for dairy cows. Transactions of the ASAE 24, 0711–0714. https://doi.org//10.13031/2013.34325

[17]. Calegari F, Calamari L and Frazzi E 2012. Misting and fan cooling of the rest area in a dairy barn. International Journal of Biometeorology 56, 287–295. https:// doi.org//10.1007/s00484-011-0432-7

[18]. Campen KA, Abbott CR, Rispoli LA, Payton RR, Saxton AM and Edwards JL 2018. Heat stress impairs gap junction communication and cumulus function of bovine oocytes. The Journal of Reproduction and Development 64, 385–392. https://doi. org//10.1262/jrd.2018-029

[19]. Chapman SC, Chakraborty S, Fernanda Dreccer M and Mark Howden S 2012. Plant adaptation to climate change – opportunities and priorities in breeding. Crop and Pasture Science 63, 251–268. https://doi.org//10.1071/CP11303

[20]. Charlier J, Ghebretinsae AH, Levecke B, Ducheyne E, Claerebout E and Vercruysse J 2016. Climate-driven longitudinal trends in pasture-borne helminth infections of dairy cattle. International Journal for Parasitology 46, 881–888. https://doi.org//10.1016/j.ijpara.2016.09.001

[21]. Chen S, Bai Y, Lin G, Huang J and Han X 2007. Isotopic carbon composition and related characters of dominant species along an environmental gradient in Inner Mongolia, China. Journal of Arid Environments 71, 12–28.

[22]. Collier RJ, Collier JL, Rhoads RP and Baumgard LH 2008. Invited review: genes involved in the bovine heat stress response. Journal of Dairy Science 91, 445–454. https://doi.org//10.3168/jds.2007-0540

[23]. Cook NB, Mentink RL, Bennett TB and Burgi K 2007. The effect of heat stress and lameness on time budgets of lactating dairy cows. Journal of Dairy Science 90, 1674–1682.

[24]. Cowley FC, Barber DG, Houlihan AV and Poppi DP 2015. Immediate and residual effects of heat stress and restricted intake on milk protein and casein composi- tion and energy metabolism. Journal of Dairy Science 98, 2356–2368. https:// doi.org//10.3168/jds.2014-8442

[25]. Craine JM, Elmore AJ, Olson KC and Tolleson D 2010. Climate change and cattle nutritional stress. Global Change Biology 16, 2901–2911. https://doi.org//10. 1111/j.1365-2486.2009.02060.x

[26]. Das R, Sailo L, Verma N, Bharti P, Saikia J, Imtiwati and Kumar R 2016. Impact of heat stress on health and performance of dairy animals: a review. Veterinary World 9, 260–268. https://doi.org//10.14202/vetworld.2016.260-268

[27]. de Andrade Ferrazza R, Mogollo´ n Garcia HD, Vallejo Aristizábal VH, de Souza Nogueira C, Veríssimo CJ, Sartori JR, Sartori R and Pinheiro Ferreira JC 2017. Thermoregulatory responses of Holstein cows exposed to experimentally induced heat stress. Journal of Thermal Biology 66, 68–80. https://doi.org// 10.1016/j.jtherbio.2017.03.014

[28]. Dikmen S and Hansen PJ 2009. Is the temperature-humidity index the best indi- cator of heat stress in lactating dairy cows in a subtropical environment? Journal of Dairy Science 92, 109–116.

[29]. Fitzgerald JB, Brereton AJ and Holden NM 2009. Assessment of the adaptation potential of grass-based dairy systems to climate change in Ireland – the maximised production scenario. Agricultural and Forest Meteorology 149, 244–255.

[30]. Galán E, Llonch P, Villagrá A, Levit H, Pinto S and Del Prado A 2018. A systematic review of non-productivity-related animal-based indicators of heat stress resil- ience in dairy cattle. PLoS ONE 13, e0206520. https://doi.org//10.1371/journal. pone.0206520

[31]. Gaughan JB, Lacetera N, Valtorta SE, Khalifa HH, Hahn GL and Mader TL 2009. Response of domestic animals to climate challenges. In Biometeorology for adaptation to climate variability and change (ed. KL Ebi, I Burton and GR McGregor), pp. 131–170. Springer-Verlag, Heidelberg, Germany.

[32]. Gauly M, Bollwein H, Breves G, Brügemann K, Dänicke S, Das¸ G, Demeler J, Hansen H, Isselstein J, König S, Lohölter M, Martinsohn M, Meyer U, Potthoff M, Sanker C, Schröder B, Wrage N, Meibaum B, Samson-Himmelstjerna G von, Stinshoff H and Wrenzycki C 2013. Future consequences and challenges for dairy cow production systems arising from climate change in

[33]. Central Europe – a review. Animal 7, 843–859. https://doi.org//10.1017/ S1751731112002352

[34]. Ghizzi LG, Del Valle TA, Takiya CS, da Silva GG, Zilio EMC, Grigoletto NTS, Martello LS and Renno´ FP 2018. Effects of functional oils on ruminal fermenta- tion, rectal temperature, and performance of dairy cows under high temperature humidity index environment. Animal Feed Science and Technology 246, 158–166. https://doi.org//10.1016/j.anifeedsci.2018.10.009

[35]. Heinicke J, Ibscher S, Belik V and Amon T 2019. Cow individual activity response to the accumulation of heat load duration. Journal of Thermal Biology 82, 23–32. https://doi.org//10.1016/j.jtherbio.2019.03.011

[36]. Holden NM, Brereton AJ and Fitzgerald JB 2008. Impact of climate change on Irish agricultural production systems. In Climate change – refining the impacts for Ireland (ed. Environmental Protection Agency), pp. 82–131. Environmental Protection Agency, Wexford, Ireland.

[37]. Honig H, Ofer L, Kaim M, Jacobi S, Shinder D and Gershon E 2016. The effect of cooling management on blood flow to the dominant follicle and estrous cycle length at heat stress. Theriogenology 86, 626–634. https://doi.org//10.1016/j. theriogenology.2016.02.017

[38]. Intergovernmental Panel on Climate Change 2014. Climate change 2014: impacts, adaptation, and vulnerability. Part A: global and sectoral aspects. In Contribution of working group II to the fifth assessment report of the Intergovernmental Panel on Climate Change (ed. CB Field, VR Barros, DJ Dokken, KJ Mach, MD Mastrandrea, TE Bilir, M Chatterjee, KL Ebi, YO Estrada, RC Genova, B Girma, ES Kissel, AN Levy, S MacCracken, PR

[39]. Mastrandrea and LL White), pp. 1–1132. Cambridge University Press, Cambridge, UK.

[40]. Kadokawa H, Sakatani M and Hansen PJ 2012. Perspectives on improvement of reproduction in cattle during heat stress in a future Japan. Animal Science Journal 83, 439–445. https://doi.org//10.1111/j.1740-0929.2012.01011

[41]. Kaufman JD, Kassube KR and Ríus AG 2017. Lowering rumen-degradable protein maintained energy-corrected milk yield and improved nitrogen-use efficiency in multiparous lactating dairy cows exposed to heat stress. Journal of Dairy Science 100, 8132–8145. https://doi.org//10.3168/jds.2017-13026

[42]. Kendall PE, Verkerk GA, Webster JR and Tucker CB 2007. Sprinklers and shade cool cows and reduce insect-avoidance behavior in pasture-based dairy systems. Journal of Dairy Science 90, 3671–3680.

[43]. Lacetera N, Bernabucci U, Ronchi B and Nardone A 1996. Body condition score, metabolic status and milk production of early lactating dairy cows exposed to warm environment. Rivista di Agricoltura Subtropicale e Tropicale 90, 43–55.

[44]. Lambertz C, Sanker C and Gauly M 2014. Climatic effects on milk production traits and somatic cell score in lactating Holstein-Friesian cows in different hous- ing systems. Journal of Dairy Science 97, 319–329.

[45]. Laporta J, Fabris TF, Skibiel AL, Powell JL, Hayen MJ, Horvath K, Miller-Cushon EK and Dahl GE 2017. In utero exposure to heat stress during late gestation has prolonged effects on the activity patterns and growth of dairy calves. Journal of Dairy Science 100, 2976–2984. https://doi.org//10.3168/jds.2016-11993

[46]. Legrand AL, von Keyserlingk MAG and Weary DM 2009. Preference and usage of pasture versus free-stall housing by lactating dairy cattle. Journal of Dairy Science 92, 3651–3658.

[47]. Liang D, Wood CL, McQuerry KJ, Ray DL, Clark JD and Bewley JM 2013. Influence of breed, milk production, season, and ambient temperature on dairy cow retic- ulorumen temperature. Journal of Dairy Science 96, 5072–5081.

[48]. Challenges in dairy farming due to climate change

[49]. Liu Z, Ezernieks V, Wang J, Arachchillage NW, Garner JB, Wales WJ, Cocks BG and Rochfort S 2017. Heat stress in dairy cattle alters lipid composition of milk. Scientific Reports 7, 961. https://doi.org//10.1038/s41598-017-01120-9

[50]. Lo´ pez-Gatius F, Santolaria P, Martino A, Delétang F and De Rensis F 2006. The effects of GnRH treatment at the time of AI and 12 days later on reproductive performance of high producing dairy cows during the warm season in northeastern Spain. Theriogenology 65, 820–830.

[51]. Ma S, Lardy B, Graux AI, Klumpp K, Martin R and Bellocchi G 2015. Regional- sclae analysis of carbon and water cycles on managed grassland systems. Environmental Modelling & Software 72, 356–371. https://doi.org//10.1016/j. envsoft.2015.03.007

[52]. Malama E, Zeron Y, Janett F, Siuda M, Roth Z and Bollwein H 2017. Use of computer-assisted sperm analysis and flow cytometry to detect seasonal varia- tions of bovine semen quality. Theriogenology 87, 79–90. https://doi.org//10. 1016/j.theriogenology.2016.08.002

[53]. Mariani P, Zanzucchi G, Blanco P and Masoni M 1993. Variazioni stagionali del contenuto in fosforo del latte di massa di singoli allevamenti. L'industria del Latte 29, 39–53.

[54]. Moallem U, Altmark G, Lehrer H and Arieli A 2010. Performance of high-yielding dairy cows supplemented with fat or concentrate under hot and humid climates. Journal of Dairy Science 93, 3192–3202. https://doi.org//10.3168/jds.2009-2979

[55]. Morgan E, Charlier J, Hendrickx G, Biggeri A, Catalan D, Samson-Himmelstjerna G von, Demeler J, Müller E, van Dijk J, Kenyon F, Skuce P, Höglund J, O'Kiely P, van Ranst B, Waal T de, Rinaldi L, Cringoli G, Hertzberg H, Torgerson P, Wolstenholme A and Vercruysse J 2013. Global change and helminth infections in grazing ruminants in Europe: impacts, trends and sustainable solutions. Agriculture 3, 484–502. https://doi.org//10.3390/agriculture3030484

[56]. Nabenishi H, Ohta H, Nishimoto T, Morita T, Ashizawa K and Tsuzuki Y 2011. Effect of the temperature-humidity index on body temperature and conception rate of lactating dairy cows in southwestern Japan. Journal of Reproduction 57, 450–456.

[57]. National Research Council 1971. A guide to environmental research on animals. National Academy of Sciences, Washington, DC, USA.

[58]. Nguyen TTT, Bowman PJ, Haile-Mariam M, Nieuwhof GJ, Hayes BJ and Pryce JE 2017. Short communication: implementation of a breeding value for heat toler- ance in Australian dairy cattle. Journal of Dairy Science 100, 7362–7367. https:// doi.org//10.3168/jds.2017-12898

[59]. Nikkhah A, Furedi CJ, Kennedy AD, Scott SL, Wittenberg KM, Crow GH and Plaizier JC 2011. Morning vs. evening feed delivery for lactating dairy cows. Canadian Journal of Animal Science 91, 113–122.

[60]. Ominski KH, Kennedy AD, Wittenberg KM and Nia SAM 2002. Physiological and production responses to feeding schedule in lactating dairy cows exposed to short-term, moderate heat stress. Journal of Dairy Science 85, 730–737.

[61]. Paes VM, Vieira LA, Correia HHV, Sa NAR, Moura AAA, Sales AD, Rodrigues APR, Magalhães-Padilha DM, Santos FW, Apgar GA, Campello CC, Camargo LSA and Figueiredo JR 2016. Effect of heat stress on the survival and development of in vitro cultured bovine preantral follicles and on in vitro maturation of cumulus- oocyte complex. Theriogenology 86, 994–1003. https://doi.org//10.1016/j.

[62]. theriogenology.2016.03.027

[63]. Pereira AMF, Titto EL, Infante P, Titto CG, Geraldo AM, Alves A, Leme TM, Baccari F and Almeida JA 2014. Evaporative heat loss in Bos taurus: do different cattle breeds cope with heat stress in the same way? Journal of Thermal Biology 45, 87–95. https://doi.org//10.1016/j.jtherbio.2014.08.004

[64]. Perring MP, Cullen BR, Johnson IR and Hovenden MJ 2010. Modelled effects of rising CO2 concentration and climate change on native perennial grass and sown grass-legume pastures. Climate Research 42, 65–78.

[65]. Phelan P, Morgan ER, Rose H, Grant J and O'Kiely P 2016. Predictions of future grazing season length for European dairy, beef and sheep farms based on regres- sion with bioclimatic variables. Journal of Agricultural Science 154, 765–781. https://doi.org//10.1017/S0021859615000830