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Effect of heat stress and cooling on cows' fertility

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Cow fertility tends to decline in the summer in hot and even temperate climates. Heat stress negatively affects all stages of the cow's fertility, among them the manifestation of "heat signs", conception and maintenance of pregnancy.

• Manifestation of "heat signs"

Heat stressed cows tend to reduce manifestation of "heat" signs. Usually, summer calving cows start cycling later compared to cool season calving cows. Summer heats are shorter and less intensive, and higher percentages of summer heats occur during the cool night hours, leading to a significant reduction in the probability for visual heat detection.

• Fertilization and conception

Heat stress negatively affects semen and egg (ovum) quality and interferes with normal synchronization between ovulation and heat manifestation. Negative effect of heat stress on ovum quality starts in early stages of follicle development (few weeks before ovulation). Ovulation time is usually delayed under heat stress conditions in relation to initiation of heat, so cows are in many cases artificially inseminated too early in relation to time of ovulation, which leads to a significant decline in their conception rate.

Low conception rates are also caused by poor body condition in summer calving cows. If not managed properly, summer calving cows tend to loose more weight after calving, which affects their hormonal activity related to fertility and is directly related to poor heat manifestation and conception rate.

• Maintenance of pregnancy

Heat stress negatively affects the probability of successful fertilization, maternal recognition of pregnancy (usually occurring 16 days after ovulation) and fertilized egg implantation in the uterus. Heat stress in advanced stages of pregnancy (first 3 months), tend to increase rate of "absorbtions" and in late pregnancy, tend to increase the rate of abortions.

The constant rise in cow-milk yields and the global warming lead to even larger decreases in cow's milk production and reproduction during summer. During the last three decades, researchers in different parts of the world have conducted research to develop efficient cooling systems which will make it possible to obtain high milk yields and relatively good fertility also during the hot season. There is no doubt that in order to achieve good results, proper installation and accurate operation of the cooling system is required.

One of the most common cooling systems widely used in many parts of the world, is the “direct cooling system”, based on the combination of wetting the cows frequently, followed by blowing air on them through forced ventilation. This system was described more than 20 years ago (1). Cooling the cows 5 times a day, 30 minutes each time, allowed cows who produced 25-30 kg of milk per day to maintain their body temperature below 39.0 C during the whole day on a typical Israeli summer day.

Conception rate to first and all inseminations was studied in cows that were cooled 7 times a day in the same procedure (2). Intensive cooling allowed cows producing 30 kg of milk per day, to maintain normal body temperature (below 39.0 C) all day around and during the whole summer, while non cooled cows had high body temperatures (above 39.5 C), during a great part of the day. The conception rate of the intensively cooled cows was significantly higher than that of the non cooled cows (59% vs. 17% and 57% vs 17%), in first and all inseminations, respectively. Pregnancy rate calculated for 90, 120 and 150 days after calving differed significantly between groups (44%, 59% and 73% vs 5%, 11% and 11%), in cooled and non cooled cows, respectively. Conception rates and pregnancy rates obtained in intensively cooled cows in this experiment were similar to those obtained during the winter of that year, on Israelian commercial dairy farms. Different from the data presented above, cows producing 45-50 kg of milk per day and cooled with the same intensity as described above, were not able to maintain normal body temperature during the whole day, in similar climatic conditions. They reached better conception rate than cooled cows, but with lower conception rates than in the winter. It seems that in order to achieve better fertility results in high yielding cows inseminated in the summer, the cows must be cooled more intensively and in higher frequency than what was done in previous years.

In the last decade surveys have been conducted, with the aim to evaluate the effectiveness of the implementation of cooling systems in commercial farms located in different hot climate conditions, on productive and reproductive traits of high yielding cows.

The first survey studied the effect of cooling intensity on cow’s productive and reproductive traits. This large scale survey was carried out during four consecutive years and included 14 farms, averaging 300 cows each (3). Farms were classified into three different groups according to the intensity of cooling in summer. Cows in group 1 were cooled in the holding and feeding area for a total of 10 cooling periods and 7.5 cumulative hours per day. Each cooling period combined cycles of sprinkling (0.5 min.) and forced ventilation (4.5 min.). Cows in group 2 were only cooled in the holding area and were provided a total of six cooling periods and 4.5 cumulative hours per day. Cows in group 3 were not cooled at all. Conception-rates were 47%, 46% and 44%, and 34%, 34% and 17% for adult cows in groups 1, 2 and 3, inseminated in winter and summer, respectively ($P<0.01$). The results of this survey indicate that intensive cooling of cows in the summer can reduce the summer decline in cow’s conception rate by half.

A computerized tool: “Summer to Winter (S:W) ratio” was recently developed in Israel. It is used to evaluate each farm in the country every year and it allows us to monitor the effectiveness of a farm’s cooling system installation and operation (4). The higher the ratio is (close or above 1.0) for productive and reproductive traits, the better is the farm dealing with summer heat stress.

Based on the S:W ratios calculated for the year 2007 we tried to quantify the overall effect of an improvement in “summer management” provided by dairy farms in the country, on their annual productive and reproductive results (5). Average S:W ratio was compared between the top 24 farms and the 24 farms reaching the poorest ratios, assuming that the difference between the two groups represents the total effect of cooling and better summer management on their annual yield and reproductive traits. Cows in high ratio herds, calving in spring-early summer reached higher lactation peaks and those calving in winter, they persisted better in their lactation, compared to cows in low ratio farms. Different from winter months, summer conception rates were significantly higher in the

high ratio farms, as compared to the low ones (40% Vs 36% and 27% Vs 19%, for winter and summer, high and low ratio farms, respectively. Conception rate in high ratio herds reached near 70% of winter level, compared to only 50% in low ratio ones (6). Differently from the achieved milk production, intensive cooling in summer (which probably caused the high S:W production ratio), did not eliminate the entire decrease in summer conception rate leaving room for improvement when it comes to cooling cows in Israel for the coming years.

In the attempt to “close the gap” between seasons in what is related to cows fertility and to further improve summer conception rate, a research work on the development of supporting hormonal treatments to improve cow’s summer fertility has been carried out by researchers from the Hebrew University in Jerusalem during the last two decades,. Among these are: manipulating blood progesterone after insemination to support pregnancy, GnRH treatment in time of insemination to improve timing between ovulation and insemination and by improvement of ovum quality by hormonal elimination of aged follicles, produced under heat stress conditions and preventing them of being ovulated. A great part of these treatments was found to improve summer fertility, only when combined with intensive cooling. It is expected that future improvement in cows summer fertility will be reached by combining intensive and effective cooling treatments with hormonal treatment.

The data presented in this paper brings us to the following insights:

1. High productivity under limiting climatic conditions does not necessarily have to prevent farmers from obtaining fair reproductive results in the summer.

2. Intensive cooling the cows in summer have the potential to completely eliminate summer decline in milk production. This positive effect can be achieved even in extremely high yielding farms.

3. Intensively managing and cooling high yielding cows in summer have the potential to reduce the summer decline in conception rate by half.

4. The higher the milk production, the more intensive and frequent cooling treatments are needed.

5. Some hormonal treatments (already under research), probably have the potential to improve cow’s summer fertility, especially when being combined with intensive cooling the cows.

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