

Effective heat abatement in summer makes Israeli dairy sector more efficient, improve cows well-being and make them environment friendly

Dr. Israel Flamenbaum.....[israflam@inter.net.il]

The increase of recent years in the standard of living in developing countries has led to an increase in the demand for dairy products by their large populations. The increased demand for milk and the inability of world's dairy sectors to supply it, led to an increase in prices of international dairy commodities, like milk powders, butter and cheese. As a result of this situation, many developing countries have begun to develop their local dairy sectors for milk self-sufficiency. On the other hand, countries that have the potential for lower production costs, have recently expanded their dairy industries and their contribution in international commerce in dairy products.

Global warming and the constant increase in cow's level of production (more heat produced and need to be dissipated), bring the heat load in summer, to be a financial problem, which causes large losses to great part of the dairy sectors in the world, especially those located in warm

areas and make use of European breeds, under intensive production systems.

The purpose of this paper is to present to the readers, the required information about how heat stress negatively affect the high yielding cows, the optimal ways of deal with the problem, the expected improvement from properly installing and operating heat stress abatement means and the cost effectiveness of the process. Bringing this information to dairy producers in different continent, as well as dairy companies, professional supporting systems and government officials, will help enhancing world milk production, improve farms profitability and reduce seasonality in milk supply to the consumers, caused mainly due to climatic factors.

The data presented in this article have been studied during the last 30 years in Israel. The reason we started working on this item were the combination of warm and



humid climatic conditions we face in summer and the high yields obtained by our cows (actually, averaging 12,000 kg/cow, annually), which means, the generation of more heat to be dissipated to the atmosphere. I believe that the knowledge and experience gained in Israel and presented in this article will be beneficial to dairy farms in different parts of the world, facing similar problems under similar conditions

The optimal temperatures for the dairy cow range between -5 and 22 degrees Celsius. In warm and humid areas, the high yielding dairy cow will start suffering from "heat stress" even at temperatures below 20 degrees. "Heat stress" is a physiological and behavioral situation, caused by cow's inability to dissipate all the heat she generates to the environment. Readers should know that the amount of heat emitted by the high yielding cow equals to that emitted by 20 lamps of W100 each, or alternatively, by three hair dryers operating continuously. The inability to lose all the heat generated, leads, in the first stage, to the operation of "defense mechanism" designed to reduce heat production (by reducing activity and feed intake), and later on, in second stage, by trying to increase heat loss (by panting and increase blood flow to cow's surface). In both cases, cows face a reduction in energy availability, needed to support energy demand for milk production.

Under heat stress conditions, cows can't equilibrate their body temperature to a normal level (ranging 38 to 39 degrees Celsius). Having body temperatures above 39 degrees, cows are considered as "heat stressed". The intensity and duration of heat stress during the day, as well as number of hot days during the year, are in close relation with the degree of summer decline in cow's performance and production losses. Heat stress can cause a reduction of about 20% in cow's daily feed consumption and a decrease of more than 10% in feed efficiency (food to milk conversion rate). As a result of these effects, milk production is expected to decrease at least by 10% to 20%, as compared to that obtained in the winter. Summer heat stress negatively affect cow's annual yield. Cows from high yielding herds are expected to lose between 500 to 1500 kg annually, as compared to similar cows raised in temperate parts of the world. Milk fat and protein content are falling as well, amounting to 0.4 and 0.2 percent units respectively, in summer, as compared to winter conditions. In parallel, and as a result of the "stressful" conditions, cows are expected to have also higher somatic cells count in milk of about 100 000 units. Conception rate of cows inseminated

in the summer may drop considerably compared to that obtained in those inseminated during winter months. Cows inseminated in summer months reach less than 10% conception rate, significantly different from the 40-50%, reached in winter inseminations. The poor conception rate reached in the summer increase "calving interval" which reduce milk production efficiency and also, cause higher proportion of cows leaving the herd due to infertility, creating large gap in milk supply between seasons.

Intensive efforts were made in Israel, during the last thirty years to develop effective means for heat abatement. Emphasis was made to the development of cooling means which suit the climatic conditions and housing characteristics, trying to reach it in the lowest cost, in order to be economically justified.

There are two main methods for cooling cows in summer. One is the "direct cooling" system, where we cool the cows by evaporating water over cow's skin, using a combination of alternating wetting and forced ventilation. Direct cooling should cool the cow, without any impact on ambient temperature. The second method is the "indirect cooling", where cowshed barns are cooled through mechanically means. Usually, indirect cooling system requires closed and, if possible, isolated barns. There are various ways to provide indirect cooling to the cows, among them, air conditioning (a method was examined and found to be not economically feasible), fogging and evaporative pads. These means are usually effective in dry areas, where the relative humidity do not exceed 30%. In more humid areas, cooling the air by water evaporation is limited to noon and afternoon hours, where, relative humidity tends to be low.

Direct cooling is the most common cooling method in use in world dairy farms today. This is mainly due to the fact that this is a relatively cheap to install and operate and the fact that it can easily be adapted to different climate types. Cooling through a combination of wetting and forced ventilation was implemented, and tested for the first time in Israel in early eighties. Cooling can be provides in the "waiting yard" before and between milking sessions, in the feed line and in the resting area. In a study we realized in Israel in the mid-eighties, we found that, by directly cooling the cows several times a day, for 30 minutes each, we prevented the expected increase in cow's body temperature, keeping them, during all day time below 39 ° C. In the same time, body temperatures of non cooled cows reached more than 40 ° C for most of the day.



Due to their high heat production, resulting from the high milk yield, it is necessary to cool the cows in Israel for several cooling sessions per day. In a survey conducted few years ago in large dairy farms in Israel, we examined the relationship between the duration of cooling treatment provided to high yielding cows and their milk production and conception rate. Average daily milk production of cows from farms intensively cooling the cows was decreased by only 0.5 kg per cow/day as compared to that obtained in winter months (a decline of only 1.5%), while, in farms without cooling, a drop of 3.5 Kg per day was registered (a decline of more than 10%).

Data analysis of last survey, led us to the development of a new index called the "Summer to Winter (S:W) ratio index". This index is used to assess the degree of "damage" caused by summer heat stress conditions to cow's performance and the improvement obtained, when cooling means were used. Investigating the Israeli dairy sector, we found that actually, close to 35% of the dairy farms the have a S:W ratio of 96% and above (farms that probably properly cool the cows in summer), but, near 25% of the farms have S:W ratio lower than 90%, (indicating that they lose more than 10% of their production potential in the summer, probably due to the fact that they are not cooling the cows at all, or not cooling them properly). On national level, we found marked improvement through the years, in Israeli cow's summer performance. From 1994 to 2004, average daily yield per cow in the winter months was increased by 2.3 kg (6%), whereas in summer, the average daily yield was increased by 7.3 kg (23%). Average S:W ratio for all Israeli dairy farms was increased during this period from 82% in 1994 to 96% in 2008, indicating a

significant improvement in the performance of the Israeli cow, probably in consequence of properly adopting and implementing intensive cooling measures in the farms.

Cooling cows in the summer is required to late pregnancy heifers and cows, as well as to milking cows, in all stages of lactation. Priority must be given to cows after calving and early stage of lactation, expected to be in high production level. Cooling cows in summer, impact positively their milk production in the entire lactation. A large scale survey carried out recently in Israel, with thousands of cows included, showed that annual milk yield of cows, intensively cooled in summer, was by 800 kg higher than that of cows in farms with minimal cooling (11,800 and 11,000 kg/year, respectively), an addition of 6.5% in their annual production. By intensively cooling both late pregnancy heifers and cows, as well as milking cows in all stages of lactation, we expect cow's annual milk production to increase by 10%, as compared to cows in farms which do not cool the cows.

Is cooling the cows cost effective?

To give an answer to this important question, we have recently developed a special computer program that calculates the "cost – benefit" ratio and the additional net income per cow and farm, reached from effectively cooling the cows in summer. The software takes into account in one hand, the cost of cooling, which includes the investment on cooling equipment and its operation along the summer, as well as the additional feed, required to support the increase in milk production. On the other hand, it takes in account the extra income resulting from the additional milk production, the improvement in milk composition

Table 1
Additional annual income per cow (U.S \$) as a result of the implementation of intensive cooling means in the summer in various countries around the world.

Country / % improvement	5% improvement in milk and feed efficiency	10% improvement in milk and feed efficiency
Israel (Coast)*	170	340
USA (South)	150	345
México (North)	165	380
China (South)	140	310
Argentina (Santa Fe)	80	200
Peru (Coast)	145	240
Brazil (Minas Garais)	145	310

* Under quota system

and quality, the improvement in feed efficiency and in reproductive and health traits, reached by cows, cooled in the summer. In the last five years, I calculated the cost effectiveness of cooling cows in Israel and in more than 20 countries in different parts of the world. Based on data provided by local dairy experts from every country, the additional annual income per cow and farm as calculated, assuming that cooling improves cow's annual yield and feed efficiency by 5% and 10%. The results of these studies are presented in table 1.

From the data described in table 1 we learn that, cooling the cows in summer is cost effective in all countries studied. Differently from the rest of the countries studied, the results from Israel are based on the production under "production quota" system, where, the benefit from cooling must be calculated differently from that in non quota system. In countries under production quota system, the economical benefit from cooling is expected to be lower as compared to countries without quota limits, as the economical benefit in this case is only the saving in maintenance expenses, when producing the milk quota by lower number cows and heifers. A greater economical benefit to cooling can therefore be expected in Israel, in case of future liberalization of quota system.

Until now, we dealt with the productive and economic aspects of cooling cows in the summer, but there are as well, other aspects of cooling effect on cows welfare and environment sustainability.

It is thought that waking and standing in the cooling process, negatively affect cow's rest time and well-being. Apparently, the reality is totally different. A recent

study, carried out in Israel examined the effect on milk production, resting and ruminating time, between cows receiving 5 versus 8 "cooling sessions" per day (225 and 360 cumulative minutes of cooling per day, respectively). Cooling cows for a longer period contributed to additional 8% in daily feed consumption and 10% in daily milk production. Surprisingly, cows, cooled for longer period, spent significantly more time per day resting and laying down (480 and 430 minutes per day) and ruminated for significantly longer time (445 and 415 minutes per day). The results of this study indicate that cooling the cows in summer, in addition to its economical value also contribute to cow's welfare in the warm season.

What about the environment? How does cooling influence the environment?

It is well known that the process of milk production is involved with the emission greenhouse gases (GHG) into the atmosphere (mainly methane CH₄ and oxygen dioxide CO₂). Apparently, GHG emission is highly correlated to level of production. Anyhow, GHG emission to the atmosphere per liter of milk produced is reduced, in parallel to the increase in cow's level of production. GHG emission by Israeli cows, producing approximately 12,000 kg/year, is expected to be 40% of that emitted by New Zealand cows, producing 5000 kg/year and 80% of European cows, producing 9,000 kg of milk per year. By increasing their milk production through cooling in summer, Israeli cows are considered more "environmentally friendly", due to the lower amount of GHG to be emitted to the atmosphere for every unit of milk produced.

In Conclusion, effective and efficient cooling systems, developed and successfully implemented in the last 3 decades in Israel are available today to dairy producers all over the world. These cooling means are capable to reduce the negative impact of summer heat on cow's performance. Proper installation and operation of cooling systems on farm level, can increase by about 10% cow's annual milk production, as well as milk composition and quality and feed efficiency. By this, cooling the cows significantly reduces cost of production in the summer, leading to remarkable increase in per cow and farm's annual income and profitability. At the same time, cooling contribute to improving cow's welfare, allowing them to rest and ruminate for longer time in warm summer days and makes milk production more sustainable, by reducing green house gases emissions into the atmosphere for every unit of milk produced.