Implementation of Israeli knowledge and experience to cool dairy cows in the world

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In a lecture I gave at the 29th Israel Dairy Conference, held in Jerusalem in November 2017, I presented the principles of my work in consulting dairy farms around the world on coping with negative effect of summer heat stress, and the achievements we reached in different countries due to the correct implementation of cow cooling methods. At the beginning of my lecture, I presented the basic conditions for obtaining the best results from cooling the cows, in projects in which I operate, based on the knowledge and experience that we have accumulated in Israel over the past four decades,

Among the conditions mentioned I included, optimizing ventilation speed and wetting quality, sufficient "living space" in the cooling yards and waiting areas and prevention of crowding, cooling the cows many times a day (one every 4 hours) and cooling also at night time. I recommended to begin cooling gradually, already in late spring and end cooling in late fall. It is recommended that cows will be provided sufficient fresh water and food that is available 24 hours a day.

The goal we have set for ourselves in Israel, and which I am trying to achieve in the projects abroad, is to maintain cows in "thermal comfort" (body temperature below 39.0 C), at most hours of the day, during all the summer. For this purpose various means were used for dissipation of heat from the cows, making use of the knowledge and experience that we have accumulated in this topic here, adapting it to the special conditions of each dairy farm.

My consultancy service to farms around the world includes the following steps:

- Filling out a questionnaire by the owner / manager of the dairy farm.
- First visit to farm site (usually takes place during winter and spring).
- Providing recommendations for proper installation of cooling systems, adapted to the special conditions of the dairy.
- Installation of cooling equipment, done by sub-contractors, (preferably until the end of March in the northern hemisphere September in the southern.
- Second visit to the farm before the summer, to examine installation quality and providing farmer with operation recommendations (operating protocol).
- Maintain continuous contact with the dairy farm along summer months, and receive a monthly report.
- Measurement of high frequency of cow's body temperatures (using intra vaginal data loggers), and providing guidelines as needed and in real time.
- Third visit to the farm, to summarize farm results, and based on them, givie instructions for the next summer (takes place in autumn and early winter).

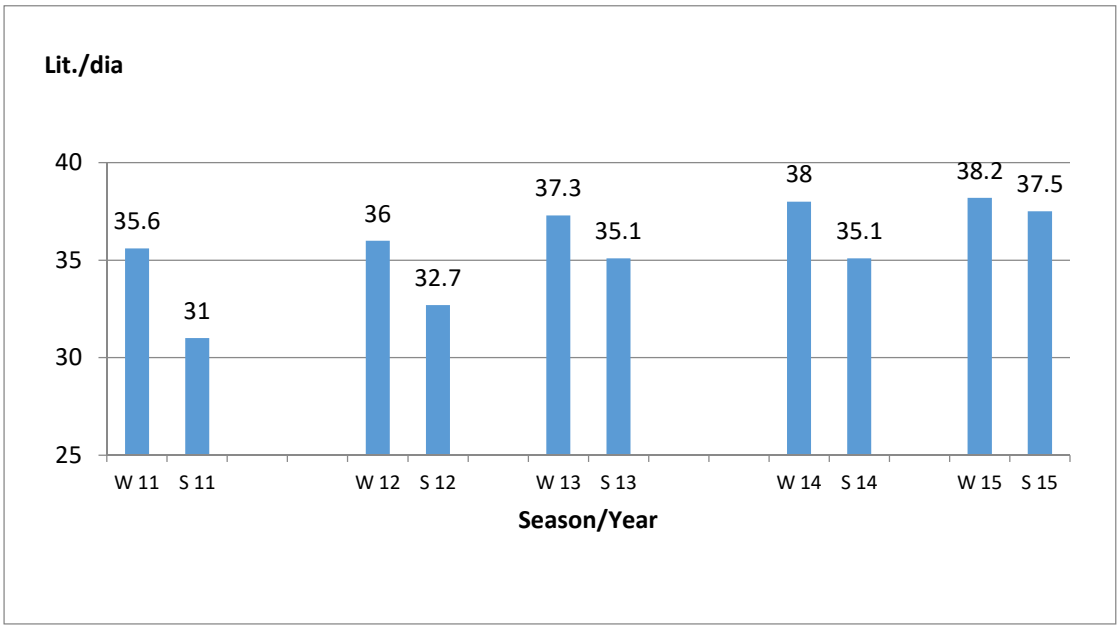
Among the countries in which I have been consulting in the last decade are those in Latin America (Mexico, Argentina, Brazil, Peru and Chile), Europe (Italy, Spain, Poland, Hungary, Romania, Greece, Cyprus, Russia and Ukraine), and Asia (Turkey, Azerbaijan, Vietnam, and China).
Due to time limitation of my lecture, I decided to present the results from three cooling projects that I am accompanying. One from every continent.

A. **Cooling project in the dairy barns of one of the greatest dairy cooperative in northern Mexico 2014-2016**

   The project took place in a desert region in the north of Mexico, with 6-8 months per year with heavy heat conditions, all or most part of the day. The dairy farmers cooperative has about 30 members in the northern part of the country, with relatively large scale farms (1000 - 4000 cows per farm). The cows in these farms are milked in "carousel" milking parlors, mostly with "Afimilk" advanced milking equipment. The cows in these farms are milked three times a day and total milking duration is usually of 21 hours a day. Feeding the cows is based on a Total Mixed Ration (TMR) that is distributed in the summer at high frequency 24 hours a day. The farms use mostly "American genetics" and the average annual milk yield per cow exceeds 10,000 liters. In the summer of 2015, the farms participating in the "cooling project", installed and operated intensive cooling systems that included wetting and forced ventilation in waiting yards and "special cooling yards", designated with the intention of expanding cooling time, trying to reach 6 cumulative hours of cooling per day.

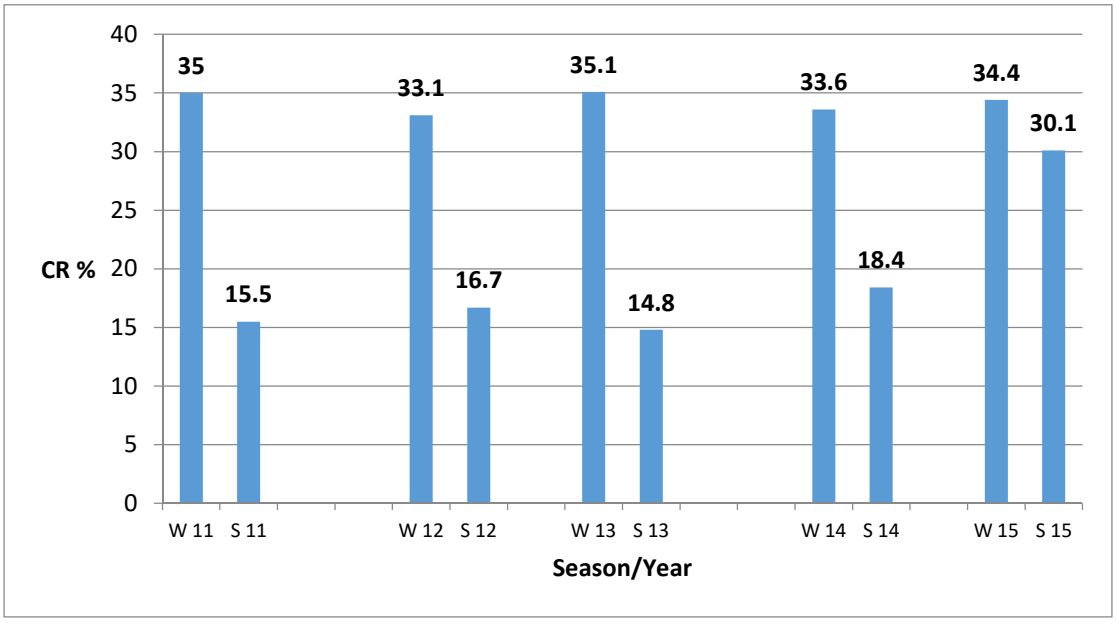
The results of cow cooling project in north Mexico in summer 2015, as compared to the four of years before, are presented as averages of 5 participating farms (near 10,000 cows), in figures 1 and 2.

Figure 1 - The average per cow daily production, in the winter (W) months (January - March) and the summer (S) months (June - August) in the five dairy farms in 2015, where intensive cooling was provided to the cows, and in the years 2011-2014, without cooling.



The conception rate of total inseminations performed each month was chosen as a representative indicator of the effect of intensive cooling on the reproductive performance of the cows. The total conception rate from the inseminations given in summer of 2015, with intensive cooling, was significantly higher in all the farms in the project than in the years 2011-2014, without cooling. The general conception rates during the summer months in the dairy farms, whose production data were presented above are shown in Figure 2.

Figure 2 - The average conception rate of all the insemination given in the winter (W) months (January - March) and the summer (S) months (June - August) in the five dairy farms in 2015, where intensive cooling is possible and in the years 2011-2014, without cooling.



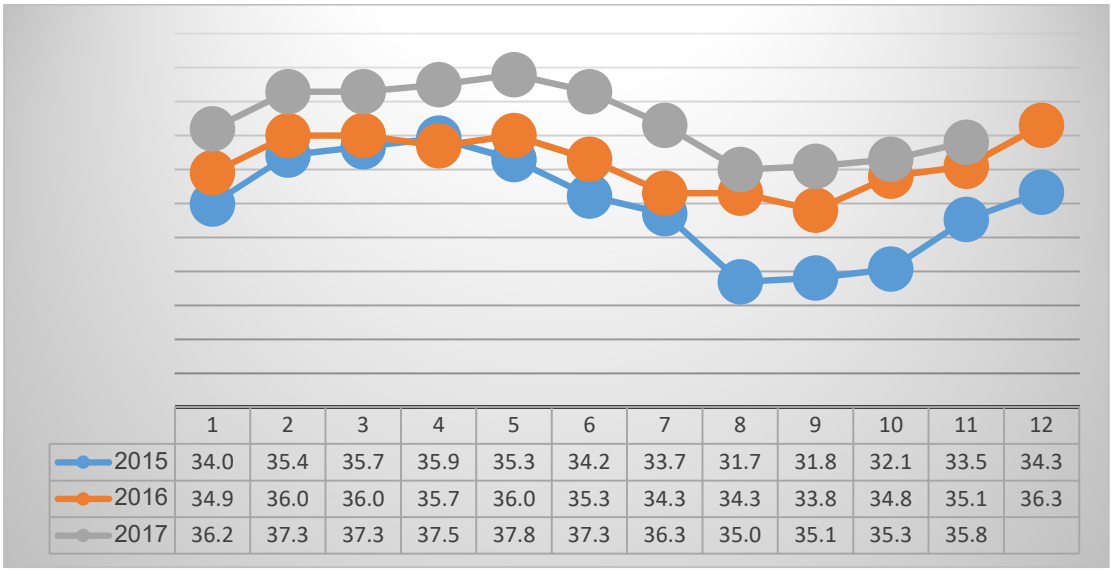
Implementation of the cooling project involved considerable financial investment, in the installation and operation of cooling systems. In general, investments in equipment for the designated cooling yards, as well as required additions in the waiting yards of the project's farms ranged from 400,000 USD in relatively small farms to 800,000 USD in the large ones (between 200 and 250 USD per cow). The operating cost of the cooling system during the summer was of 45 USD per cow, of which 30 USD was for electrical power. Using a special computer program that I developed recently, I examined the economic feasibility of investing in intensive cooling of cows. When analyzing the data of a farm with 3,000 cows, which invested $ 800,000 in the installation of the cooling system, I found that the recommended cooling operation contributed to a net income increase of 200 USD per cow a year and 600,000 USD to the farm (return on investment in less than two years).

B. **Cooling project in the Cirio dairy farm, owned by the "Beneton" family in southern Italy 2016 - 2017**

Cirio dairy farm was one of the first farms where I started working in Italy, located

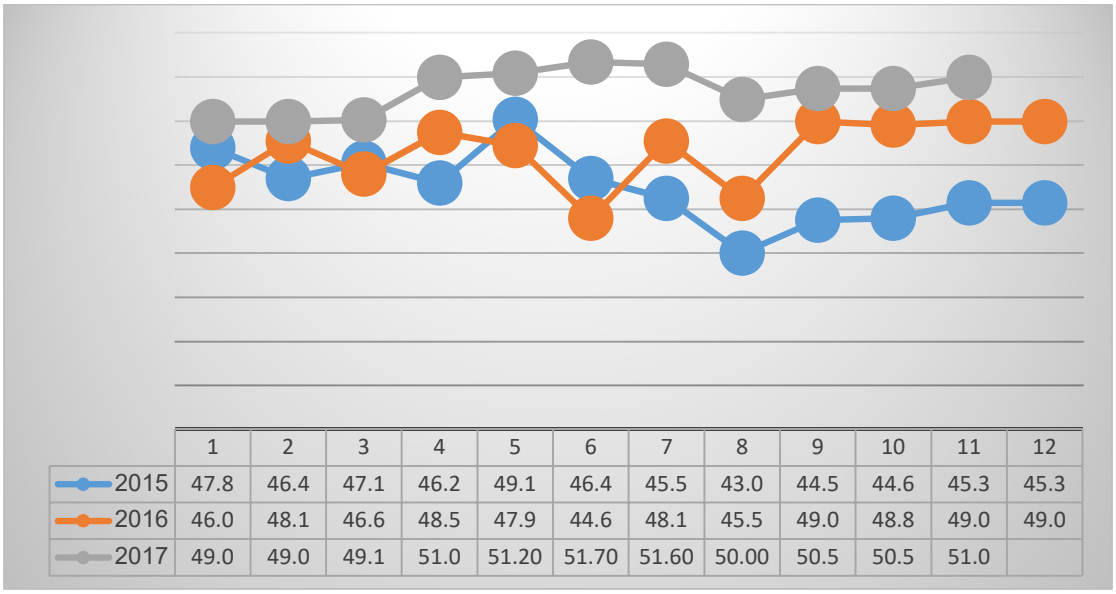
near the city of Naples. The farm is owned by the Benton family, with many businesses and assets in Italy and abroad, including agricultural projects. In this farm are 1800 milking cows, milked in two "paralel" milking parlors, and are housed in old buildings free stalls with relatively large density. The annual yield of the cows, before the start of our joint work was about 10,000 liters per cow. My first visit to Cirio farm was in early June 2016, so there was little that could be done for the summer of this year, only to improve the quality of wetting and introduce a cooling protocol for the summer that was already underway. Due to manpower limitations, it was not possible to cool the cows during the night and also to cool the dry and late pregnant heifers. Despite these limitations and due to the improvement in summer management practices, the performance results in summer 2016 were significantly better, as compared to those of previous summers. This improvement encouraged farm manager to invest towards the summer of 2017 with the addition of ventilation and improvement of cooling in the waiting yards and along the feed lines. Curtains were installed in front of the feeding lines and the waiting yards to prevent penetration of solar radiation and to block side winds to disturb the wind flow of forced ventilation, when walkways to the milking parlor were shaded too. Body temperature measurements conducted in the summer of 2016 using intra vaginal inserted data loggers convinced the dairy manager, in preparation to the summer of 2017, to cool the cows also at night and also to cool the dry cows and heifers before calving. The production and fertility performance in the Cirio farm, in summer 2015, before the introduction of cooling, in summer 2016, with partial cooling and in summer 2017, with complete cooling treatment, are shown in Figures 3, 4 and 5.

Figure 3 – Average daily milk production per cow (liters), in Cirio farm in 2015 -2017.



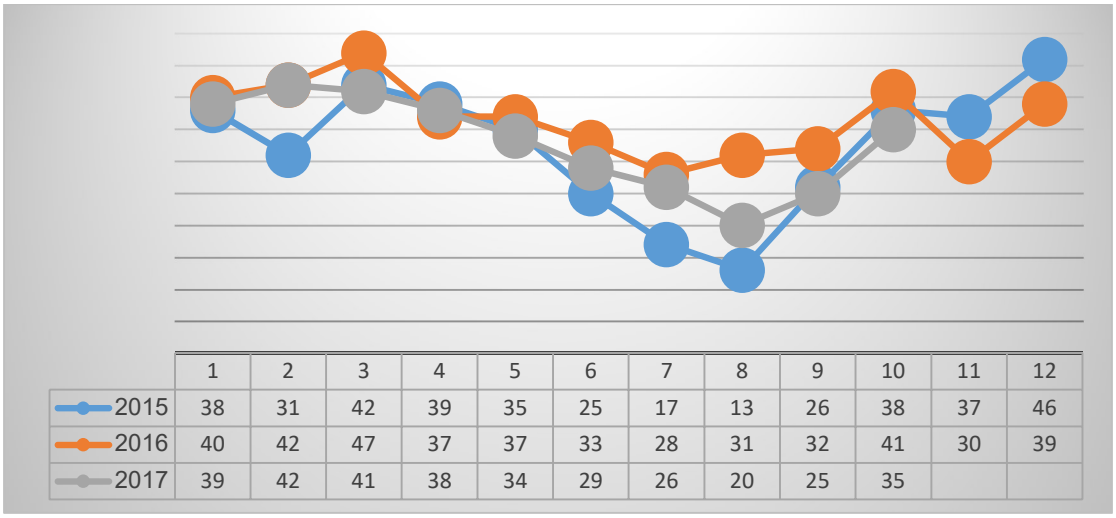
	1	2	3	4	5	6	7	8	9	10	11	12
2015	34.0	35.4	35.7	35.9	35.3	34.2	33.7	31.7	31.8	32.1	33.5	34.3
2016	34.9	36.0	36.0	35.7	36.0	35.3	34.3	34.3	33.8	34.8	35.1	36.3
2017	36.2	37.3	37.3	37.5	37.8	37.3	36.3	35.0	35.1	35.3	35.8	

Figure 4 - Average "peak yield" (week 8 of lactation, liter / day), in adult cows in the Cirio farm in 2015 – 2017.



	1	2	3	4	5	6	7	8	9	10	11	12
2015	47.8	46.4	47.1	46.2	49.1	46.4	45.5	43.0	44.5	44.6	45.3	45.3
2016	46.0	48.1	46.6	48.5	47.9	44.6	48.1	45.5	49.0	48.8	49.0	49.0
2017	49.0	49.0	49.1	51.0	51.20	51.70	51.60	50.00	50.5	50.5	51.0	

Figure 5 – Conception Rate of total insemination, given to adult cows in Cirio farm in 2015-2017.



	1	2	3	4	5	6	7	8	9	10	11	12
2015	38	31	42	39	35	25	17	13	26	38	37	46
2016	40	42	47	37	37	33	28	31	32	41	30	39
2017	39	42	41	38	34	29	26	20	25	35		

Also for Cirio farm, I have conducted an economic study to evaluate for the cost effectiveness of investing in intensively cooling the cows in the summer. The increase in milk production due to the cooling treatment was calculated by comparing cow's average milk production in 2015, before the starting our joint work and 2017, when cooling system was operated completely. The investment in cooling equipment was of 300 Euros per cow and 550,000 Euros for the entire dairy farm (in fact, the investment was lower because farm was already equipped with some cooling equipment). The cost of running the summer cooling system was 40 Euro per cow, mostly for electricity. The installation and operation, as recommended contributed to

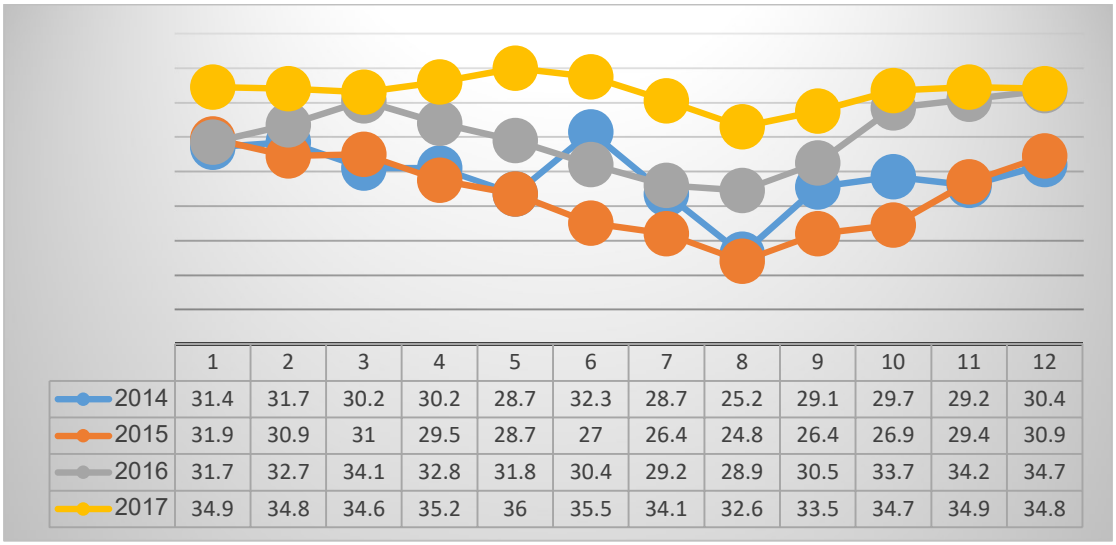
the additional annual net income of 250 Euro per cow and 460,000 Euro per farm. (Here too, the return of the investment is in less than two years).

C. Cooling project in the "Ozlem" dairy farm in Mediterranean coast of Turkey 2016 - 2017

Ozlem dairy farm is located near the city of Izmir Mediterranean coast. The farm consist of 1500 milking cows, housed in two barns with free stalls, and are milked three times a day at a double" paralel" milking parlor. The total milking time is 21 hours a day. The cows were cooled in two waiting yards, before the milking and for some groups of cows, also between milking sessions. Cows were also cooled in the feed line and forced ventilated above free stalls in rest time. As in Italy, also in Turkey, due to the fact that my first visit to the farm was realized in the beginning of the summer of 2016, the improvement in the cooling of the cows was partial, and included the installation of cooling system was completed in the waiting yards and feed line of only one of the barns. Complete cooling the cows as recommended, including cooling the cows at night and cooling dry cows, was provided only in summer 2017. Vaginal temperatures of the cows, measured in summer 2017 showed that cooling treatment "worked well", and that the cows were maintained in thermal comfort, 24 hours a day.

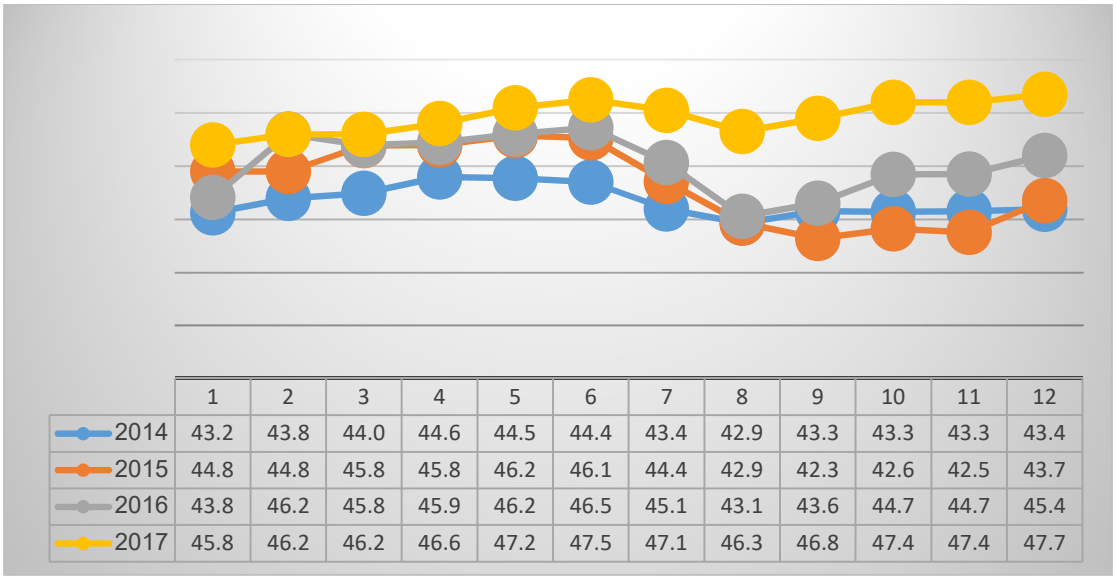
The production and fertility performance in Ozlem farm, in summer 2015, before the introduction of cooling, in summer 2016, with partial cooling and in summer 2017, with complete cooling treatment, are shown in Figures 6, 7 and 8.

Figure 6 – Average daily milk production per cow (liters), in the Ozlem farm in 2014-2017.



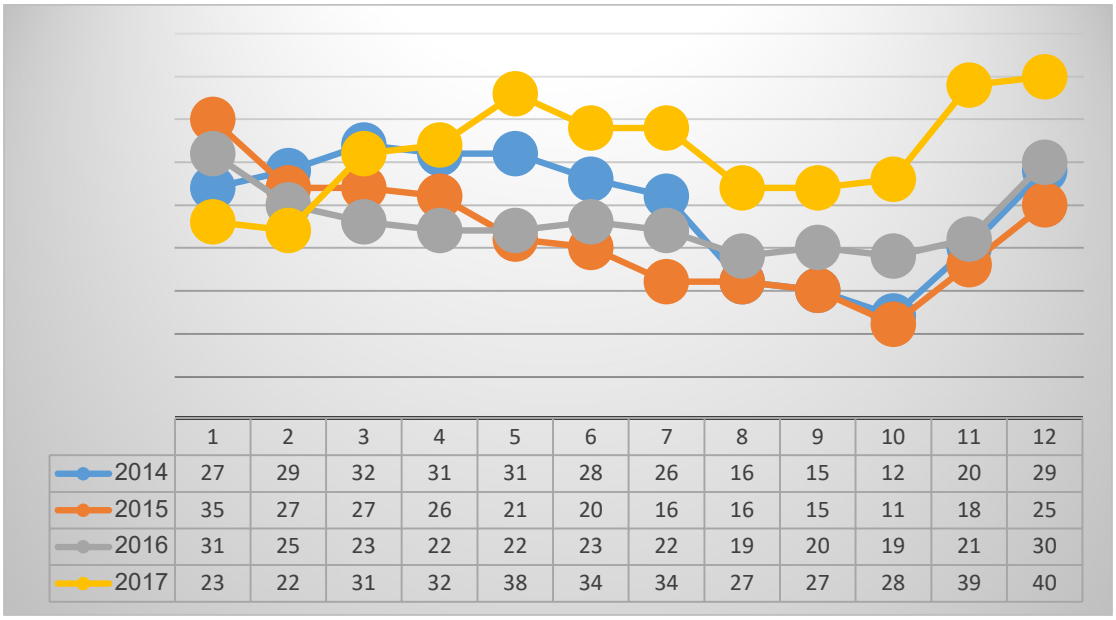
	1	2	3	4	5	6	7	8	9	10	11	12
2014	31.4	31.7	30.2	30.2	28.7	32.3	28.7	25.2	29.1	29.7	29.2	30.4
2015	31.9	30.9	31	29.5	28.7	27	26.4	24.8	26.4	26.9	29.4	30.9
2016	31.7	32.7	34.1	32.8	31.8	30.4	29.2	28.9	30.5	33.7	34.2	34.7
2017	34.9	34.8	34.6	35.2	36	35.5	34.1	32.6	33.5	34.7	34.9	34.8

Figure 7 – Average peak daily milk production (liters), in adult cows of Ozlem farm, in 2014-2017.



	1	2	3	4	5	6	7	8	9	10	11	12
2014	43.2	43.8	44.0	44.6	44.5	44.4	43.4	42.9	43.3	43.3	43.3	43.4
2015	44.8	44.8	45.8	45.8	46.2	46.1	44.4	42.9	42.3	42.6	42.5	43.7
2016	43.8	46.2	45.8	45.9	46.2	46.5	45.1	43.1	43.6	44.7	44.7	45.4
2017	45.8	46.2	46.2	46.6	47.2	47.5	47.1	46.3	46.8	47.4	47.4	47.7

Figure 8 – Conception rate from all insemination given to the cows in Ozlem farm in 2014-2017.



	1	2	3	4	5	6	7	8	9	10	11	12
2014	27	29	32	31	31	28	26	16	15	12	20	29
2015	35	27	27	26	21	20	16	16	15	11	18	25
2016	31	25	23	22	22	23	22	19	20	19	21	30
2017	23	22	31	32	38	34	34	27	27	28	39	40

As with previous projects, I conducted an economic study to evaluate cost effectiveness of the implementation of intensive cooling, also in Ozlem farm. Evaluation of the increase in milk production due to cooling the cows was done by comparing cow's milk production in 2014 and 2015, before we started working together, to those of 2017, which has just ended, and where cows were completely cooled according to my recommendation. The investment for the installation of cooling equipment was of 150 USD per cow, and 225,000 USD per farm (the investment was relatively low, since the farm already had a cooling system when we started our joint work.) The cost of operating the cooling system in the summer was 30 USD per cow. Farm gate milk price was of 0.43 USD, food price was 0.26 USD per kilogram of Dry Matter (DM) and kWh of electricity was 0.12 USD. Annual Milk production per cow in Ozlem farm increased between 2014 and 2017, in 1580 liters (annual increase from 9,000 to 10,700 liters, an increase of 17%). Assuming that only

half of this increase can be contributed to the improvement in cow cooling, the results of the study show an increase 300 USD in net income per cow and 450,000 USD per farm. The relatively high increase in net income per cow due to cooling the cows in Ozlem farm, can be related to the good trade relations that exist in the dairy industry in Turkey (the ratio between food and milk price).

In conclusion, the world dairy industry has been migrating in last decades from temperate climate regions to warm ones. The increase in milk yield per cow and global warming, increases the extent of the regions in the world affected by the heat stress. The milk yield and fertility of the cows are affected in the summer, causing a significant financial loss to dairy producers in the warm regions. Over the past 40 years, different cooling means have been developed and implemented in Israel to reduce heat from cows. The knowledge and experience we have accumulated in Israel are used these days to deal with summer losses in farms, located in the regions of the world that need it. In the past ten years, I have been able to advise and apply the knowledge and experience we have developed in Israel in more than 15 different countries on three continents. In the countries where I work, the intensive cooling of the cows in the summer contributed to an increase in per cow annual income of between 100 and 300 USD. In all these countries, it was found that the investment in cooling the cows in the summer is one of the most worthwhile investments and returns in less than two years.