UN Climate Change Conference COP 16

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Side Event: Agriculture and forestry under hot and arid conditions

Overcoming the effect of heat stress under hot climate on high yielding dairy cows in Israel.

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The Dairy Industry is one of the leading sectors in Israel's agriculture, and a source of pride for all Israelis.

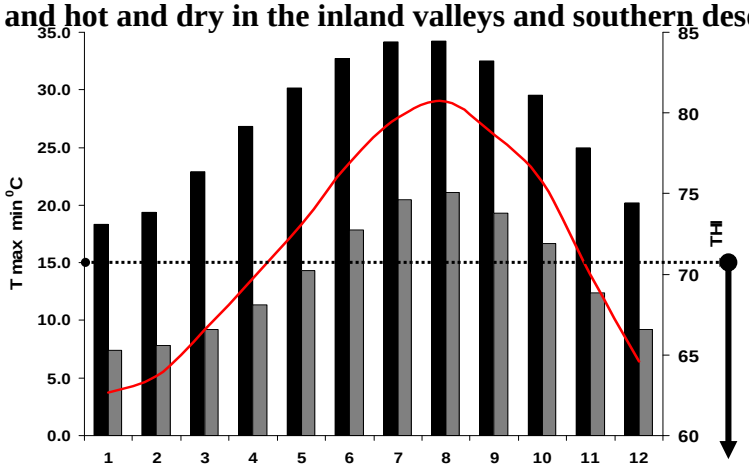
It supplies the entire domestic demand for milk and dairy products (a variety of over 1,000).

- Total annual output of 1,300 million liters of cow milk.
- The annual value of products being processed is about 1.5 billion US$ representing 10% of total agriculture output.
- Milk is produced on 970 farms, countrywide.
- The national dairy herd comprises about 120,000 milking cows of the Israeli-Holstein breed, developed by our genetic improvement system.
- The Israeli cow has been selected throughout generations and is well **adapted** to the harsh environment: long and hot summers as well as several endemic diseases.

Map of the Dairy Industry in Israel - Dairy plants and dairy farms

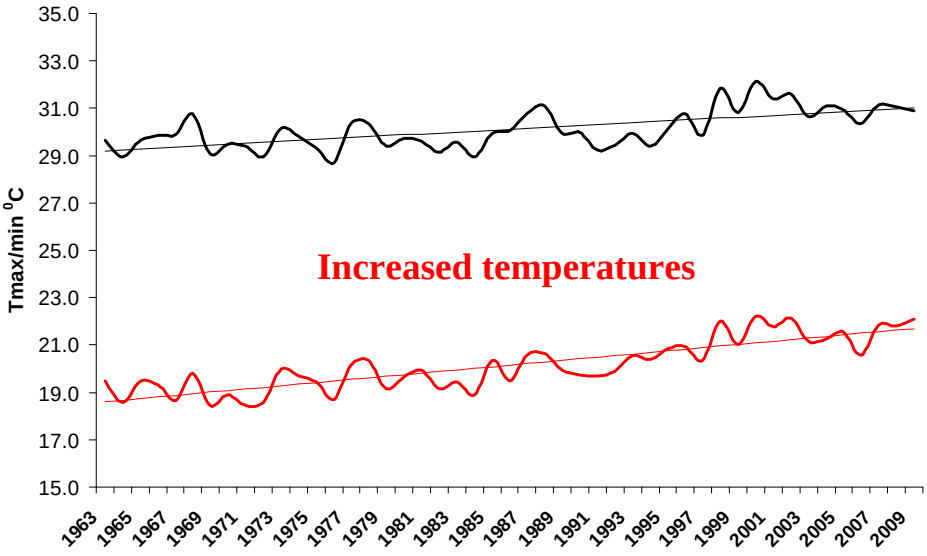
The average annual milk production is 11,800 kg per cow, containing 3.60% fat and 3.20% protein.

Israel's climate is considered subtropical and dry:
Moderately cool, rainy winters (November-March).
Summer warm and humid along the cost (May-October), (30^{0}C),
and hot and dry in the inland valleys and southern desert (40^{0}C).



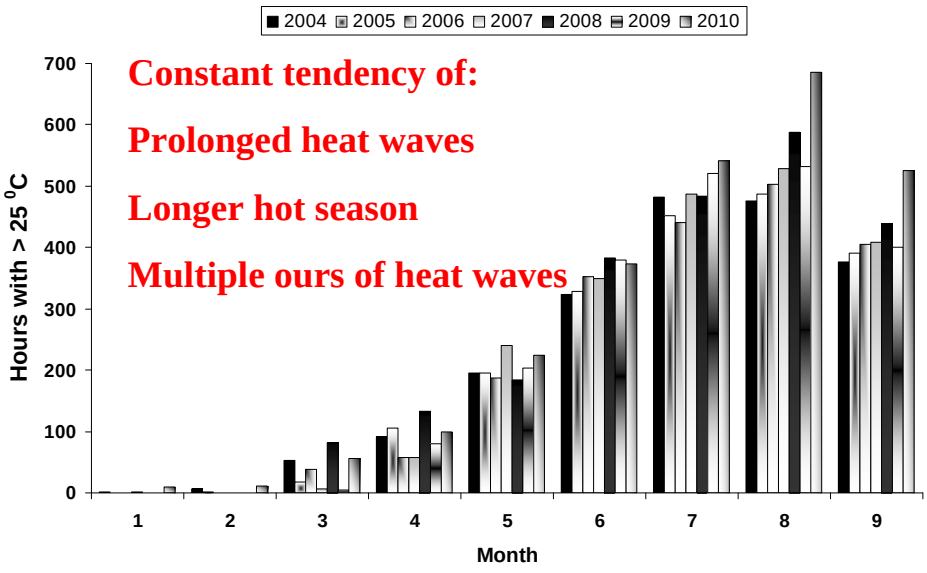
THI is a combined effect T^{0}C and RH that explains the risk of heat stress to cattle
THI > affect body temperature > affect performance
THI > 72; cattle under heat load

Israel, average temperature in august from 1963 - 2009



Bet Dagan, meteorological station examine

Israel, daily hours with more than 25 C^0 during the year



Bet Dagan, meteorological station

The constant rise in global warming is decreasing milk production during hot seasons globally.

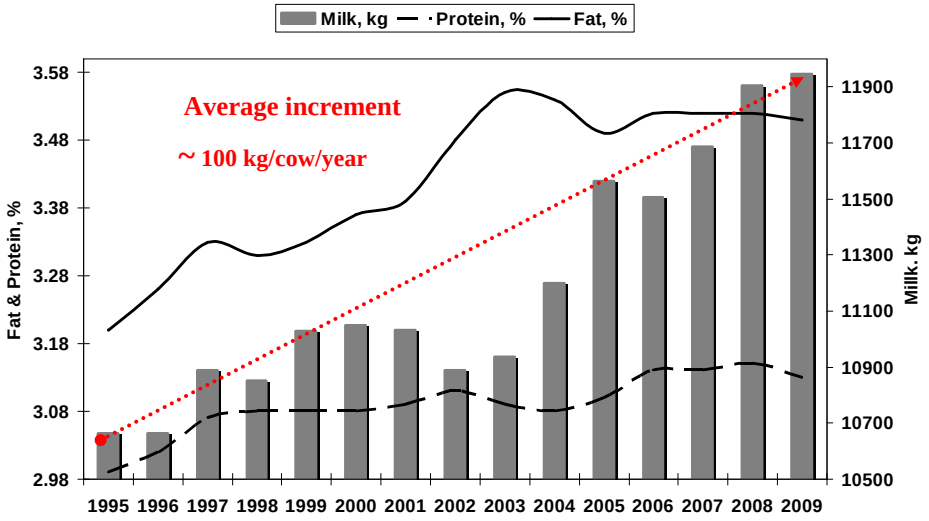
During last three decades Israeli researchers have conducted studies and surveys to develop efficient managements which may allow high milk yields during hot and humid summers.

Technologies for relieving heat load of dairy cows are rapidly being adopted by Israeli farmers.

Incentives provided by an appropriate pricing system for milk, encourage farmers to install and use those systems extensively.

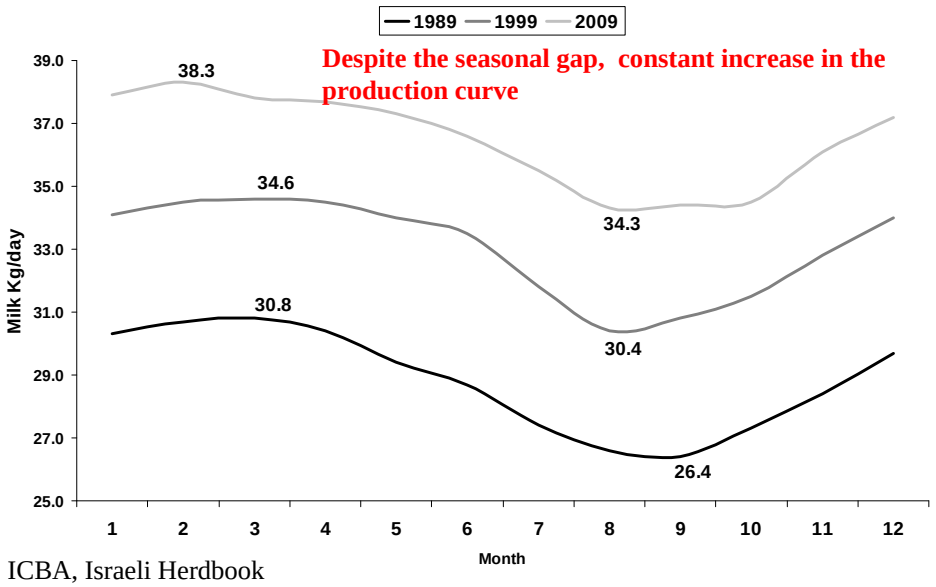
The experience gained in Israel indicates that both high productivity and production efficiency can be obtained when efficiently treating cows in summer. Similar results can be expected in other dairy sectors from hot regions of the world in the future.

ISRAEL: some facts of milk production in the last 15 years



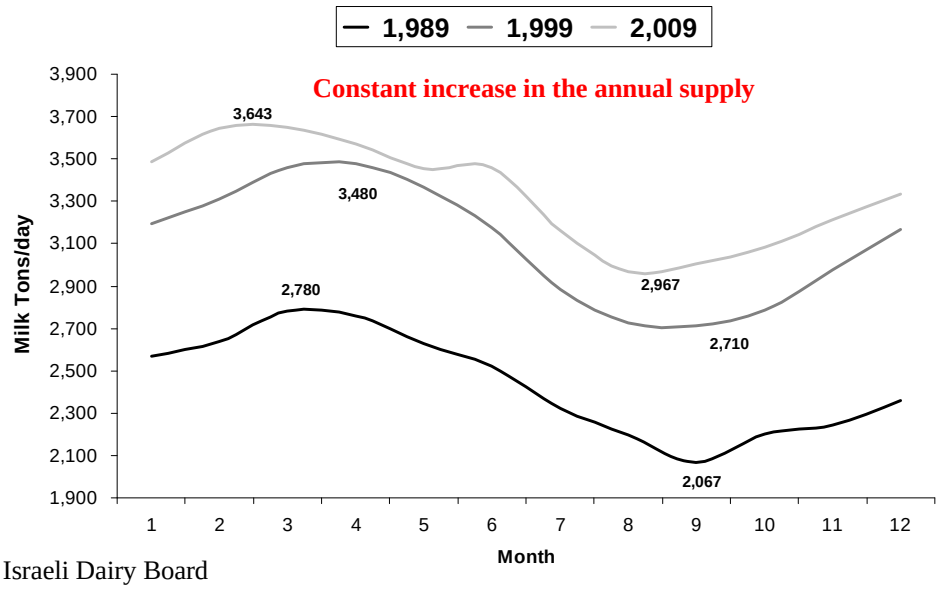
ICBA, Israeli Herd-book

Daily yield, kg/cow of monthly milk recordings of all herds 3 decades



ICBA, Israeli Herdbook

Cow milk, month supply (tons/day)



Israeli Dairy Board

Scientific background:

•Heat stress is caused by a combination of environmental factors: temperature, relative humidity, solar radiation, air movement, and precipitation.
•The majority of studies have focused mainly on T^0C and RH data reflected by the THI in the barn.
•Heat load in dairy cattle raised the cow's body T^0C due to a reduction in the temperature gradient between skin surface and the environment.
•The heat load accumulated by the cow subjected to heat stress is the sum of heat accumulated from the environment and the failure to dissipate heat associated with metabolic processes.

Scientific background…

•Ambient temperatures above the thermal neutral zone (>20 ^0C) have detrimental effects on the dairy cow under intensive management.
The negative effects include:
•Decreased voluntary intake and milk production
•Impaired fertility of the cows during hot seasons
(decrease pregnancy percent; heat less evident; follicular development and implantation of fertilized ova in uterus> leading to a decrease of calving on spring and next summer season).
•Depressing effect on calves birth weight and colostrum quality.
•Damage in development of the epithelial cells in the mammary gland of dairy cows during dry period.

Clear Signs of heat stress on dairy cows

Increased body temperature over 39^0C
Respiratory rate over 60 breaths per minute
Drop of food intake (10% or more)
Drop in milk yield (10% or more)

Other signs…

Effects on rumen health and function
Decrease efficiency of milk production
Decrease activity of the cow
Increase water intake
Increase water loss through evaporation

Dairy cows usually dissipate access heat by:

Sensible loss of heat passively to the environment via radiation, convection and conduction.

Actively dissipate excess heat by evaporative means mainly respiratory passages (high rate of breathing up to panting) and also by vaporizing water from the skin (sweating).

BUT **Cows** have limited ability to dissipate excess heat.

Methods for managing heat stress in dairy cows

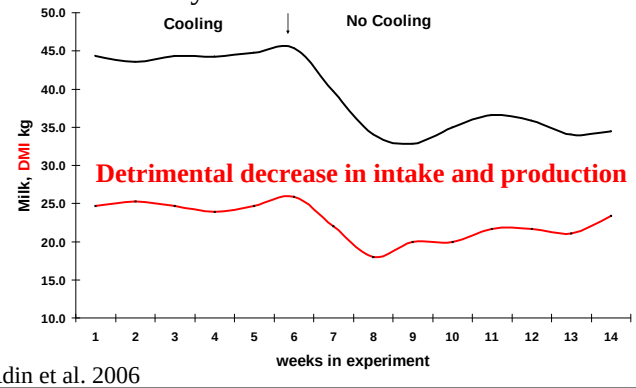
1. **Prevention or reduction of solar radiation**
   - **Shading**
   - **Whiting of roofs**
2. **Direct refrigeration (of the cow)**
   - **Showering / Wetting**
   - **Ventilation**
   - **Combination of showering and ventilation**
3. ***Combination* of direct (cow) and indirect refrigeration (environment)**
   - **Fogging or Misting / Cooler**
   - **Air Conditioning ??**
4. **Adaptation of feeding to heat load conditions**

The cooling system developed and first implemented in Israel more than 20 years ago is a combination of wetting the cows frequently followed by blowing air with forced ventilation:

6-8 cooling periods/day

Each period 30-45 minutes (5 min cycle of 0.5 min of sprinkling + 4.5 min of forced ventilation)

4.5 - 6.0 cumulative hr/day



Adin et al. 2006

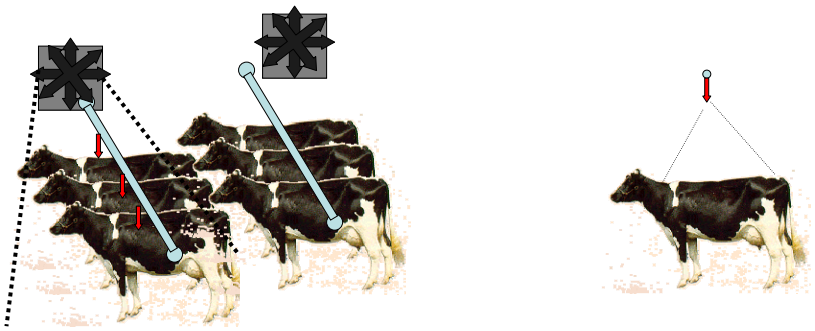
Cooling by showering and ventilation
In the holding pen of the milking parlor

Appropriate place: Size - at least 2 m^2 / cow, high roof, drainage

Equipment: Sprinklers and fans adequately placed over the cows

Schedule for system functioning:
The main cooling design is based on sprinklers used to produce a spray of droplets large enough to penetrate the hair-coat of the cow for about 20-30 seconds followed by forced ventilation fans located around to produce an air velocity of about 2.5 – 3.0 m/s at the height of the cow's body for about 4-5 minutes.

This procedure is repeated for 30-45 minutes, several times a day (every 2.5 - 3 h) for a total of at least 6-7 cumulative h/day in between 8-10 cooling periods from early in the morning to late in the night.



Sprinkler nozzle delivery: 300 lts/ hr. Consider sprinkling-degrees
Installation height of upper sprinklers: 1.5 mts over cow's back
Distance between sprinklers in a row: 1.5 mts.
Distance between sprinklers rows: 2 mts.
Water pressure

Fans: 24-28 inch diameter
Consider Air flow and overlapping. Consider air flowing angle.
Effective air flow: > 2.5 mts/sec.
Consider natural air flow

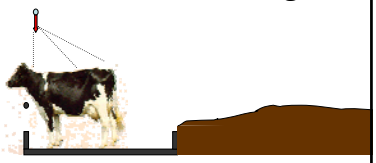

Cooling by showering and ventilation
In the holding pen of the milking parlor


Cooling by showering and ventilation
In the holding pen of the milking parlor

Cooling by showering and ventilation along the feeding line

Appropriate place: cement floor, drainage
Type of COWS' positioning at the feed alley: head-locks or free
Equipment: Sprinklers and fans adequately placed over the cows

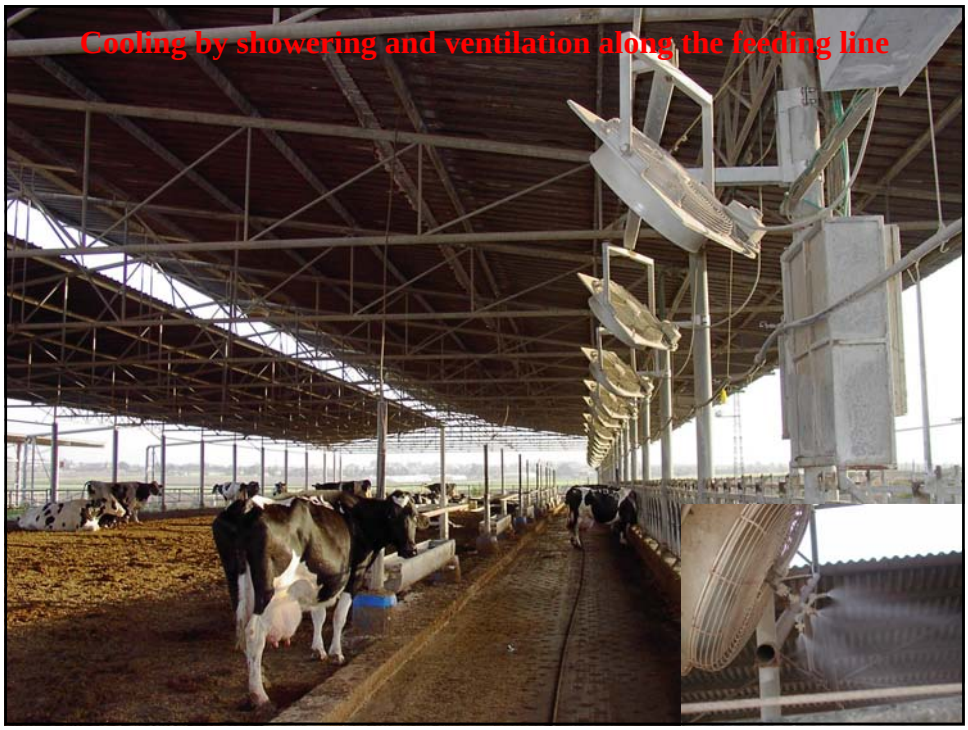
Installation height of upper sprinklers: 1.5 mts over cow's back
Sprinkler nozzle delivery: 120 lts/ hr.
Distance between sprinklers in a row: 1.5 mts.
Fans: 20-25 inch diameter
Consider: Air flow and overlapping: 6 mts between fans, air flowing angle, natural air flowing.



Schedule for system functioning:

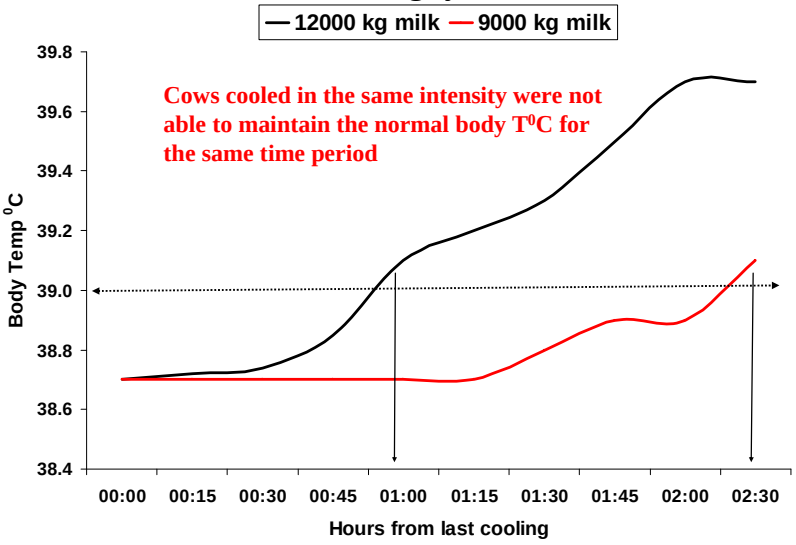
Each treatment : 30 min.
About 6 cycles/day - Each cycle consists of: 30 sec showering and 4.5 min of ventilation without showering
Frequency of treatments:
After each milking, or between milking (synchronized with food delivering)

Cooling by showering and ventilation along the feeding line



What is the optimal frequency of cooling treatments ??

Body temperature of cows with different yields under intensive cooling system,



Combination of cooling the cow and the cow surroundings

Milk yield increases constantly (genetic, management and nutrition improvement)

Higher milk yield increases the metabolic heat production and sensitivity of the dairy cow to heat load

In this case, the frequency of cooling should increase

Normally cows lay down about 8-10 hours/day, no cooling is performed in the resting place mainly because the requirement of keeping this place dry.

Cooling the air in the resting area by a moderate fogging system, may relieve the cows' heat load in the time between intensive coolings.

An **additional** system of cooling the surrounding air by water evaporation using ***fogging systems may be possible in areas with high temperature and low humidity (<47%)***

The inside temperature in the barn may be 4-6 ^{0}C lower than outside

The fog system is based on spraying the water as small drops.
The drops are easily carried by the air streams inside the building.
This results in a high efficiency of water evaporation while keeping dry area.


Combination of cooling the cow and cooling the cow surroundings
Shade net

Adaptation of feeding to heat load conditions

The main target is to re-formulate rations to enhance intake:

- Concentrate energy and adjust protein
- Reduce forage in ration and use high quality forage
- Replace part of the dietary roughage component with by-products rich in readily digestible NDF, such as soy-hulls
- Considerate mineral losses (Na, K) by sweating and urinary excretion
- Adjust the moisture content of the diet
- Ensure fresh and clean water in accessible areas, shade trough
- Feed more frequently, feed at evening/night
- Avoid fermentation at feeders (shade/mold inhibitors)
- Use palatable feeds

Resume effect of cooling or dietary treatment under heat load conditions: dry and milking cows

Effect of Cooling	Dry cows	Milking cows
Respiratory rate (min^{-1})	-31%	-13%
Rectal temperature (^0C)	-0.3^{0}C	-0.5^{0}C
Voluntary DMI (kg/d)	+15.8%	+16.4%
BCS change (1-5scale)	+0.16	+0.10
Milk yield (kg/d)	+5.3%	+23.6%
Feed efficiency (kg DMI/ kg Milk)		+6.5%
Proliferation of mammary cells	Increase	
Calves birth weight (kg)	+6.9%	
Quality of 1st colostrum (IgG g/L)	+11%	
Post parturient disorders	Decrease	

How can we evaluate the efficiency of the cooling treatment?

Based on the Israeli dairy herd-book database, a summer (S) to winter (W) performance ratio (milk yield and conception rate) is calculated

S:W close to 1 means the farm handles summer heat load appropriately with minimal summer losses

Milk and conception rates in Low and High S:W ratio	Low S:W	High S:W
Winter Milk Production (kg/d)	39.5	39.7
Summer Milk Production (kg/d)	34.4	38.7
S:W Milk ratio	0.87	0.98
Summer Conception Rate (%)	19	27
S:W Fertility ratio	0.53	0.68
Milk annual production (kg/cow)		+6.5%
Annual conception rate		+4%

What is the relation between the main object of COP 16: global greenhouse gas emission GHG-E mitigation and the high yield Israeli cow?

- Carbon footprints of agriculture and forestry contributes 30% of emission to atmosphere; 5% by all ruminants and **2% by dairy farming**
- This represents the calculated sum of annual emission of $CH_{4\ methane}$, $N_2O_{\ nitrous\ oxide}$ and $CO_{2\ carbon\ dioxide}$ by dairy cows in different countries
- About 50%-70% of the greenhouse gas emission from dairies are originated by CH_4 by digestive processes of the cow and manure storage
- CH_4 rumen production depends on rumen retention time: a feeding system based on long fiber roughages leads to high retention time and high rumen CH_4 production
- The typical Israeli feeding system makes use of relatively low quantities of forage and high quantities of grains, protein sources and industrial by-products in cows' diets.
- CH_4 emission related to 1 kg of milk, is 3 times lower in a high yield Israeli cow (11800 kg/year) compared to a low yield cow with 2000 kg/year, the total GHG-E (equivalent to CO_2 / milk kg) doubles.
- High concentrations of energy and protein in diet allow the maximization of milk production, while keeping dairy farms environmentally friendly.

Cost and benefit

The complementary effects of feeding and cooling enhance milk yield by 8% cow/year

Cooling requires investment (equipment and installations of fans and sprinklers) and operating costs (electricity, water, labor) considered to be **100 US$/cow/year**

Benefit: milk production and feed efficiency: **215 US$**

Net income 115 US$/cow/year

Intensively cooling cows in the summer has the potential to totally eliminate the summer decline in milk production

Take home message:

High milk yield in Israel in spite of difficulties:

- **Environment (heat stress) affects the cow and the roughage quality**
- **Lack of land and water (high price of feedstuff)**
- **Others (political, security)**

What is the base of success?

Genetic; Nutrition; Management

Additional advantages of the Israeli milk production concept:

- **Environment friendly cows (utilize wet industrial byproducts in nutrition).**
- **High productivity reduces cows' contribution to global warming**

Israel is engaged in transfer of agricultural knowledge across developing countries including technologies to dissipate heat load in dairy cattle

IF WE CAN, EVERYBODY CAN
we are willing to help !!

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