Lessons learned from the intensification of milk production in dromedaries

and how it may advance the camel dairy industry in arid, semi-arid countries

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What does intensive camel milk production mean?

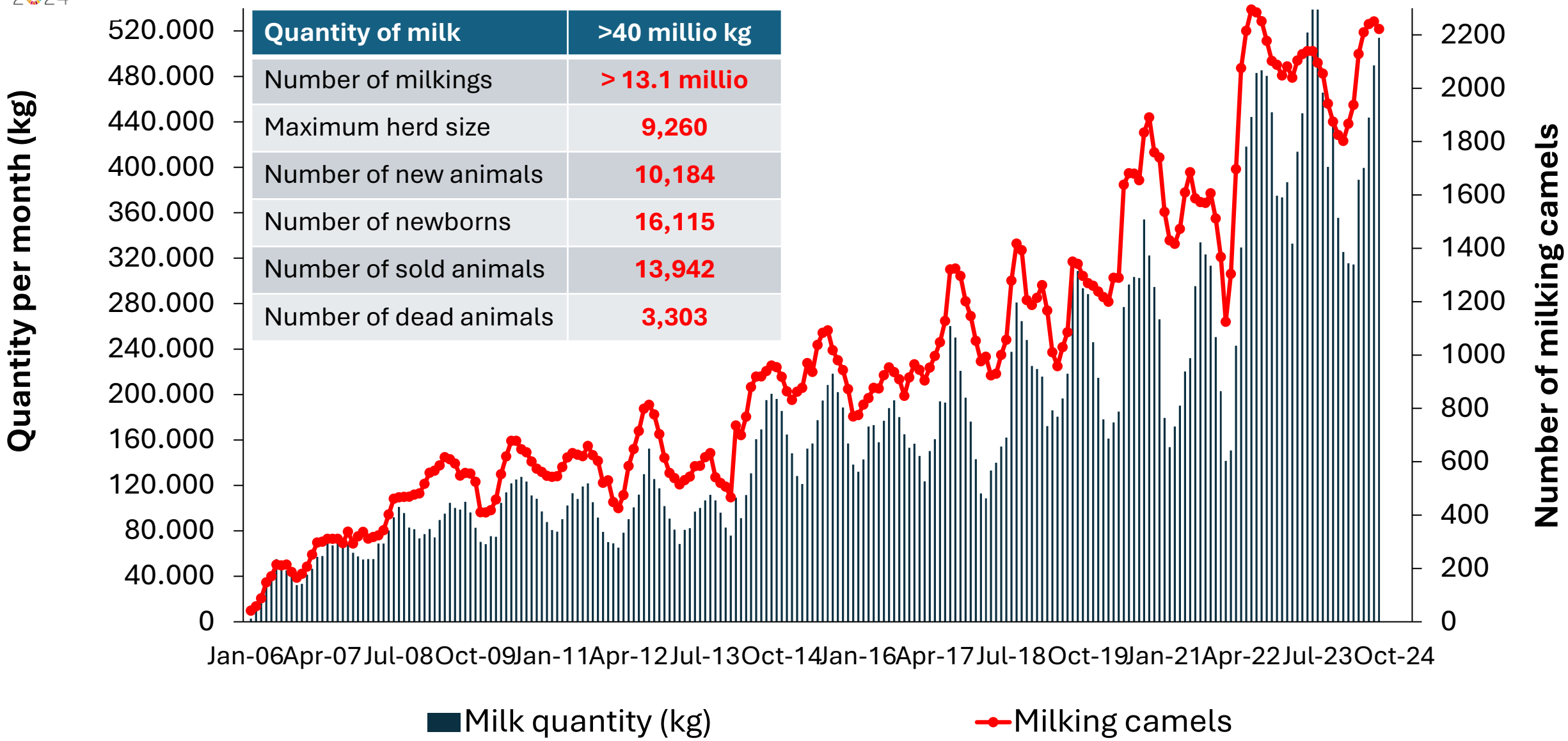
- Maximum milk yield per camel (per lactation) up to its genetic potential
- Optimal/maximum use of land with high concentration and density of animals
- Optimal/maximum use of feed resources to meet the maintenance and production requirements of the animals
- While maintaining good animal health, decreasing production losses and ensuring proper animal welfare
- Continuous selection and genetic improvement of the herd

A closed herd of “happy and healthy” camels with maximum production

INTERNATIONAL YEAR OF CAMELIDS 2024

18 years of intensification in numbers

Quantity of milk	>40 millio kg
Number of milkings	> 13.1 millio
Maximum herd size	9,260
Number of new animals	10,184
Number of newborns	16,115
Number of sold animals	13,942
Number of dead animals	3,303



What we developed and still learning continuously

- Infrastructure, Pre-requisite programs
- Milking technology and milking routine
- Animal husbandry and herd management
- **Production potential and influencing factors**
- **Interaction between genetics and environment**
- **Raw milk quality and influencing factors**
- **Seasonality**
- **Disease surveillance, incidence, control and prevention**
- Breeding management
- Environmental impact and sustainability
- **Production costs vs. milk price**
- **Efficiency of estimations (herd, input and production)**
- Importance of the human factor

Three pillars of an intensive production system

Hardware

Infrastructure,
Facilities,
Equipment
(PRPs)

Competent staff

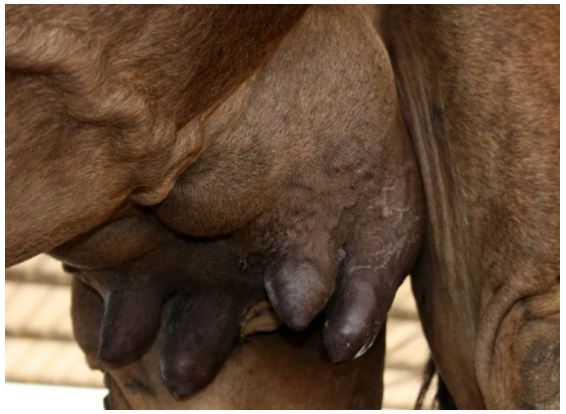
Software

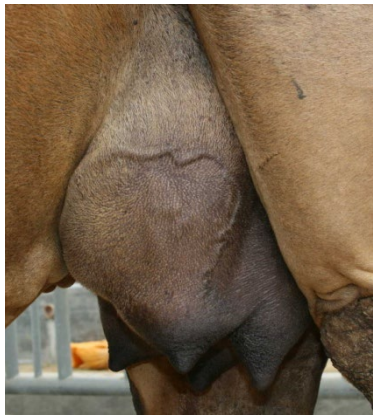
Herd health
management
Food safety
management
oPRPs, CCPs

Factors effecting milk yield

- **Management**
  - Type of milking (hand or machine)
  - Milking technology
  - Frequency of milking, data recording
  - Milking routine, milk let-down
  - Calf separation
  - Time of mating and drying off
- **Genetic components**
  - Breed / ecotype (color)
  - Individual variability
- **Physiological components**
  - Age, parity
  - Pregnancy
  - General and udder health
- **Environmental components**
  - Nutrition (quantity and quality)
  - Season and Photoperiod
  - Temperature and humidity

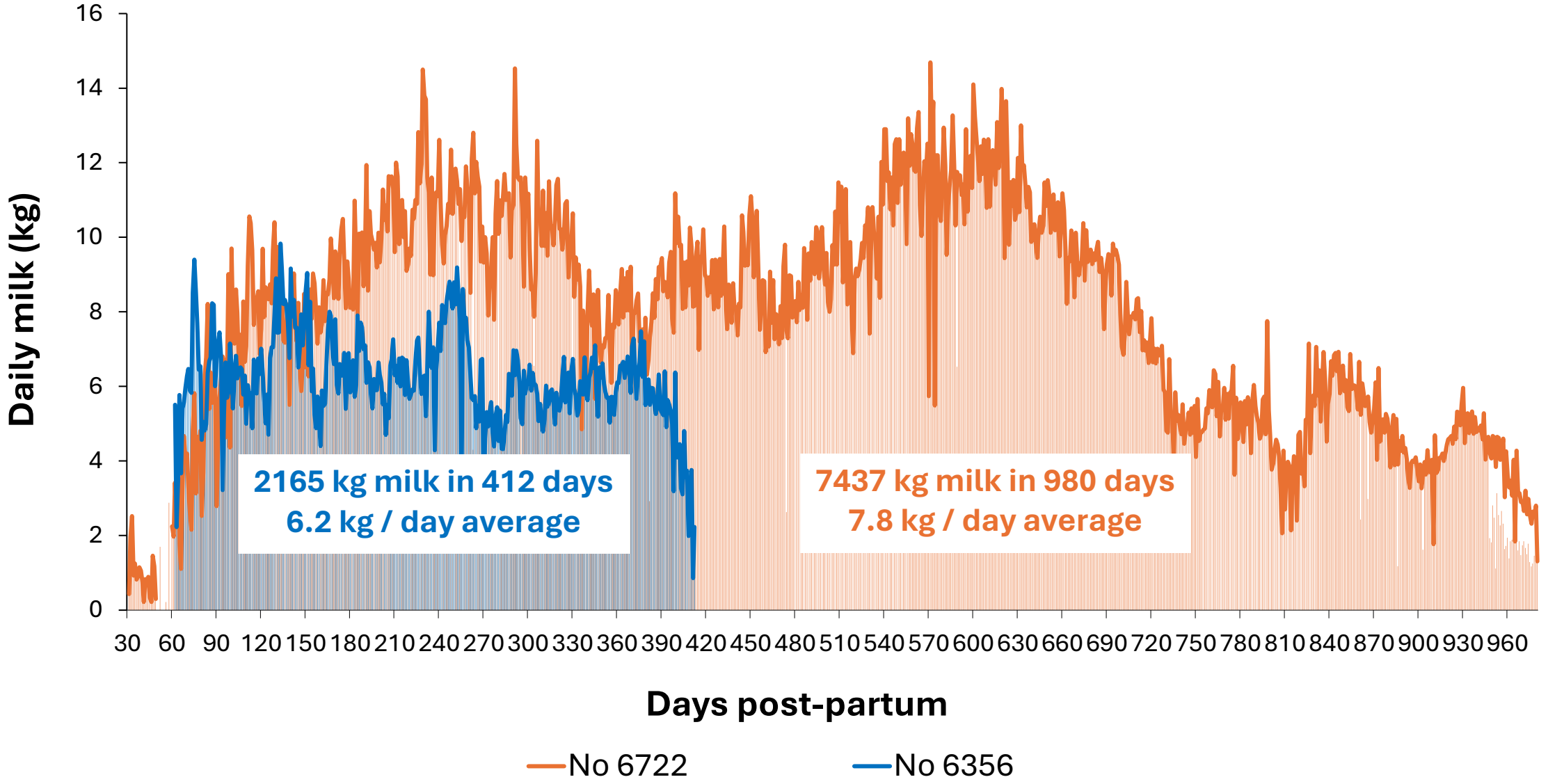
High variability in animal size, udder and teat shape and size



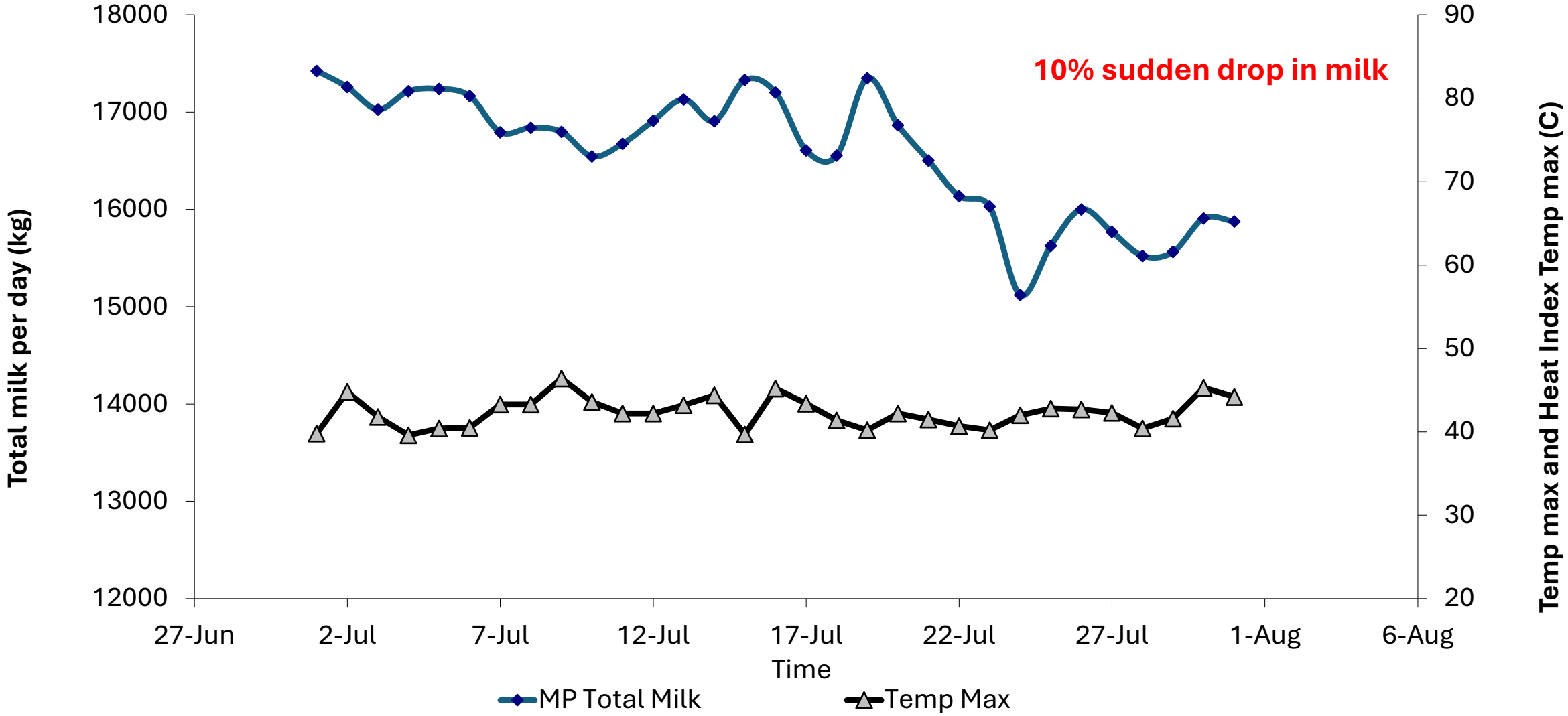


INTERNATIONAL YEAR OF CAMELIDS 2024

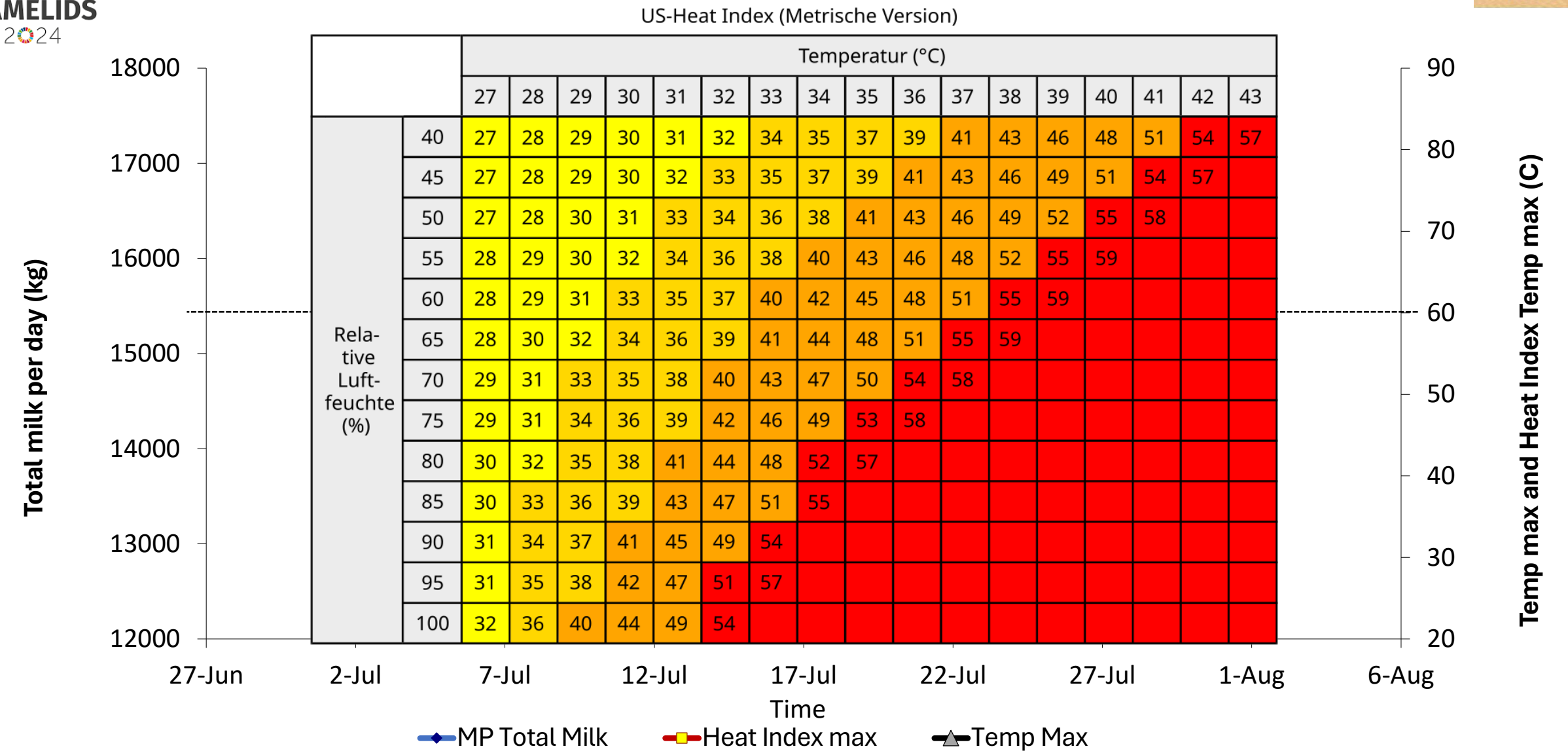
Short vs. long lactation period



Environmental effect - Heat stress in dromedaries



Environmental effect - Heat stress in dromedaries



above 60 C Heat Index temperature milk production decreases

Interaction between genetics and environment

Tropical Animal Health and Production
https://doi.org/10.1007/s11250-020-02256-z

REGULAR ARTICLES

Genetic parameters of birth weight trait in dromedary camels (*Camelus dromedarius*)

Szabolcs Bene[1] · Ferenc Szabó[2] · J. Péter Polgár[1] · Judit Juhász[3] · Péter Nagy[3]

Table 4 The estimated genetic parameters for the birth weight trait in dromedary camels

Parameter	Birth weight		
	ANOVA	BLUP1	BLUP2
σ^2_d additive direct genetic variance	2.39	2.67	2.58
σ^2_m maternal genetic variance	–	12.39	5.73
σ_{dm} direct maternal genetic covariance	–	−1.90	−0.90
σ^2_{pe} maternal permanent environmental effect	–	–	5.68
σ^2_e residual variance	23.80	11.85	11.70
σ^2_p phenotypic variance	26.19	25.00	24.78
h^2_d direct heritability	0.09 ± 0.04	0.11 ± 0.03	0.10 ± 0.03
h^2_m maternal heritability	–	0.50 ± 0.06	0.23 ± 0.10
r_{dm} direct maternal genetic correlation	–	−0.33 ± 0.23	−0.23 ± 0.31
c^2 the ratio of the permanent environmental variance to the phenotypic variance	–	–	0.23 ± 0.08
e^2 the ratio of the residual variance to the phenotypic variance	0.81 ± 0.04	0.47 ± 0.03	0.47 ± 0.03
$h^2_m + c^2$	–	–	0.46
h^2_T total heritability	–	0.24	0.17

- birth weight is affected more **by environmental factors**
- the dam's intra-uterine rearing capacity (maternal genetic effect)
- the environment, management, feeding of pregnant female camels (maternal permanent environmental effect)
- direct heritability is low (hereditary growth potential of the calf)
- Similar finding for gestation length

Strong seasonal effect

milk quantity

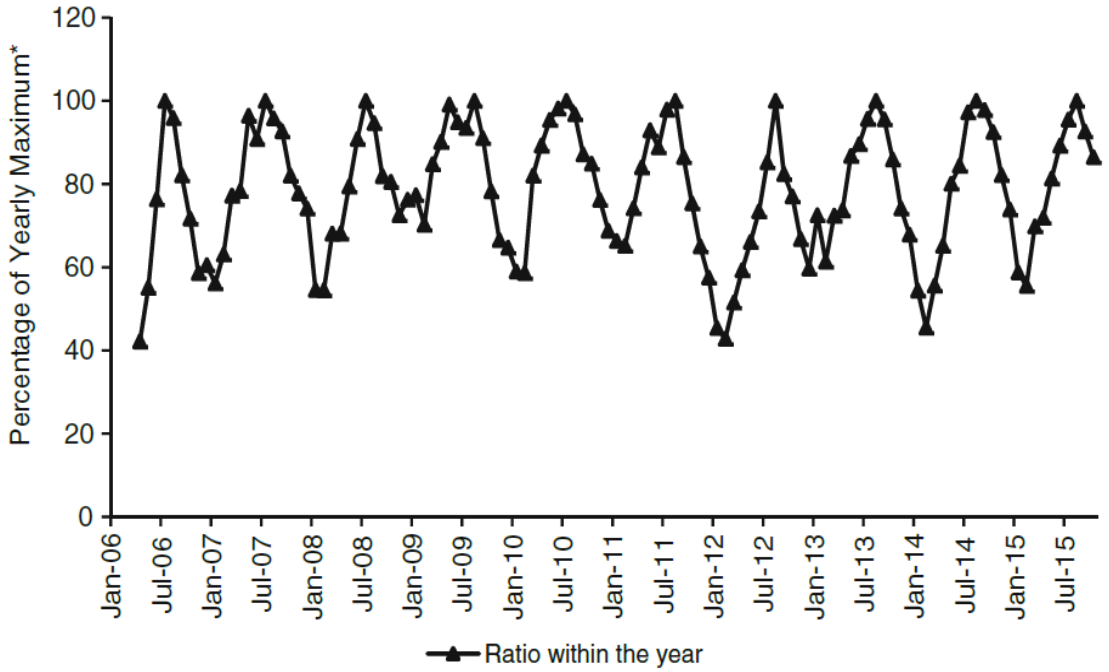


Fig. 7 Seasonal fluctuation in total milk production between 2006 and 2015. Values are calculated as the ratio of total monthly quantity and yearly maximum

milk composition

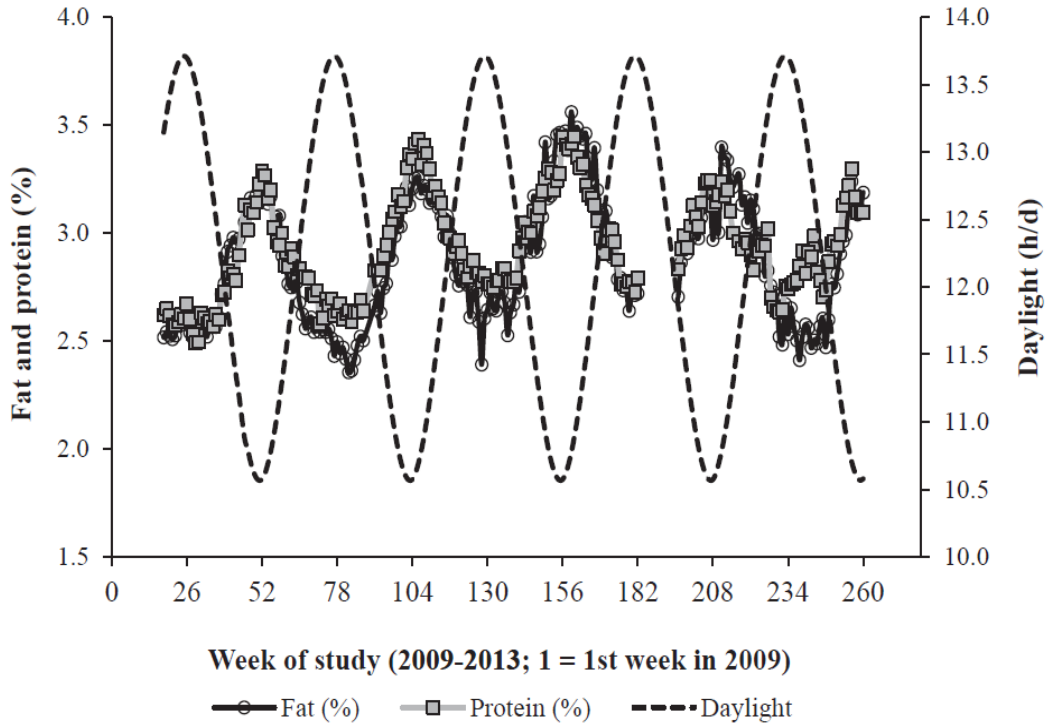


Fig. 2. Temporal relationship between circannual variation in weekly mean fat and protein percentages of bulk dromedary camel milk and length of daylight in the United Arab Emirates (25° N, 55° E).

Nagy and Juhasz, 2016

Nagy et al., 2019

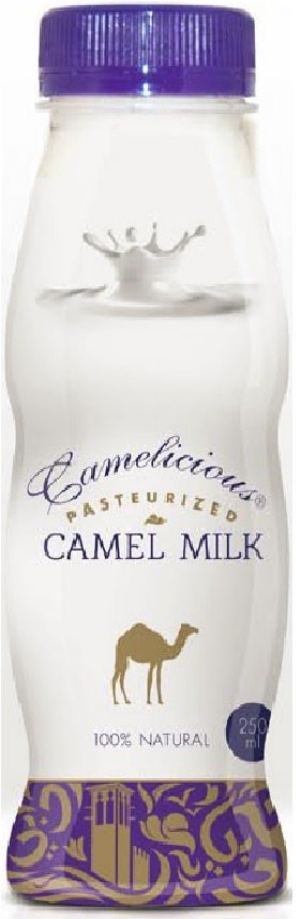
Production losses – Diseases
Neonatal mortality

Location	Supervisor	Delivery (n)	Dead (n)	Ratio (%)
Farm 1	I.	616	48	7.8
Farm 1	II.	359	23	6.4
Farm 2	III.	578	123	21.3
Farm 2	IV.	292	36	12.3
Total		1845	230	12.5

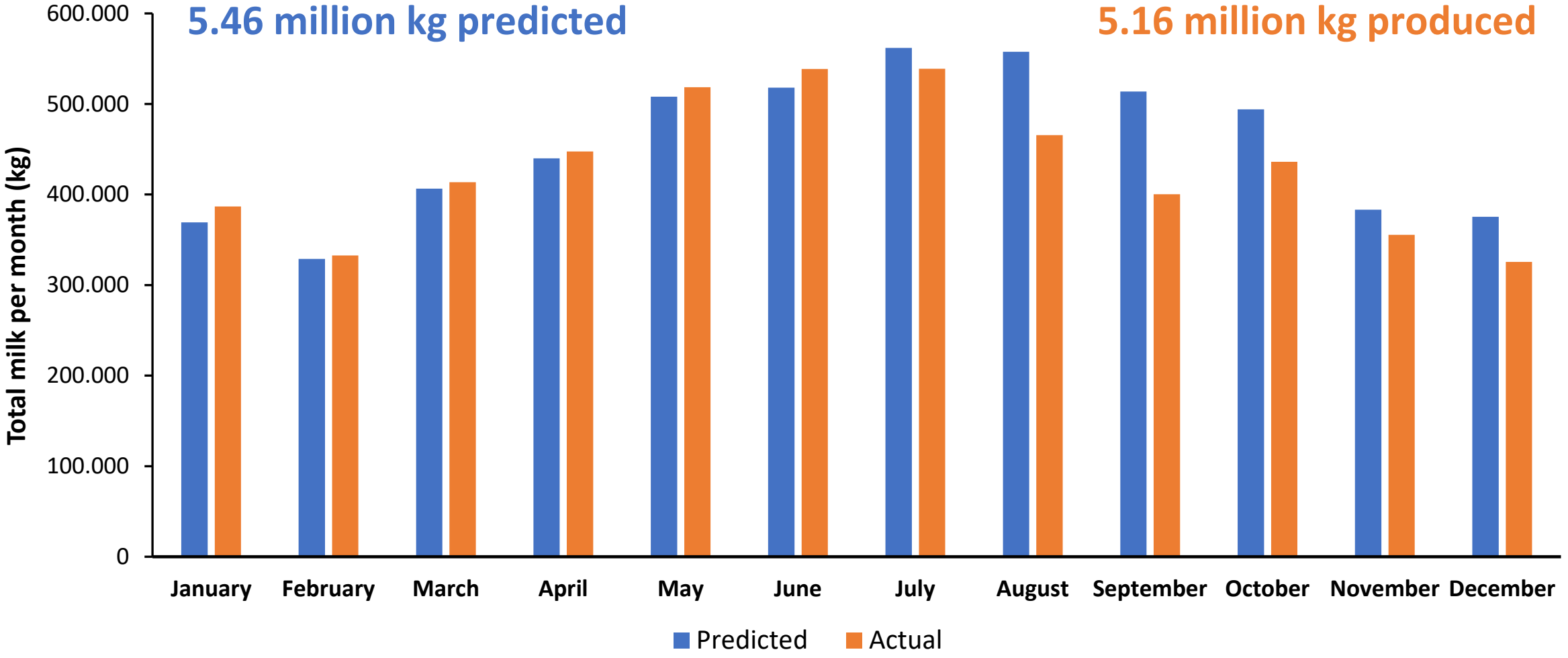
Farm 1 and Farm 2 are one epidemiological unit under the same herd health program and veterinary care

Production costs vs. milk price

- The retail price of 1 liter pasteurized camel milk is 18.5 AED
- This is 3x times the price of pasteurized cow milk
- Consumers need strong and valid claims to spend more
- Despite, there is a minimum profit for the producer
- Reasons for the high production cost of raw camel milk
  - **camel physiology and relatively low production potential**
  - **high manpower requirement**
  - **high cost of imported feed**
- Added value products are needed (powder, ice cream, chocolate)



Modelling and production prediction



94.6% accuracy of prediction for 16 months

Herd structure and daily production modelling comparison of short vs. long lactations

	Option I. only short lactation	Option II. combination of 2	Difference
Number of camels to purchase to reach target from the 2019 level (head)	5000	3800	< 1200
Number of milking camels from the 3rd year	3000	3100-3200	> 100-200
Ratio of milking camels / total number of adults (%)	44-40	50-48	> 8
Number of breeding camels	3800-4600	3100-3400	< 700-1200
Number of pregnant camels	3100-3700	2500-2700	< 600-1000
Total number of adult animals	6800-7600	6200-6600	< 600-1000
Daily milk production (kg)	21000	21000-22000	

Intensive camel dairy

Advantages

- High quality product
- Efficient production chain
- Predictability
- Continuous veterinarian supervision
- Improved animal health and welfare
- Well regulated and traceable
- Selected breeding and genetic improvement

Disadvantages

- High investment, slow initial return
- Confined animal movement
- Gap between professional and traditional animal husbandry and herd management
- Increased risk of spreading diseases
- Increased risk of developing antibiotic resistance
- Environmental impact

Additional “side-effects” of intensification

- Increased public awareness of camel milk
- Laid the foundation for internation trade of camel milk
- Facilitated to change existing legislation and to develop new ones
- Draw the attention of international organizations (FAO, CAC, EAAP i.e.)
- Contributed to the initiative to develop international camel milk standard
- Triggered many individuals and companies to establish similar projects all over the world
- Created a “gold mine” of data for research

Harmony and beauty of an intensive production system if all pieces of the puzzle fit together