ACHIEVING OPTIMAL COW PERFORMANCE WITH THE AID OF INFORMATION SYSTEMS

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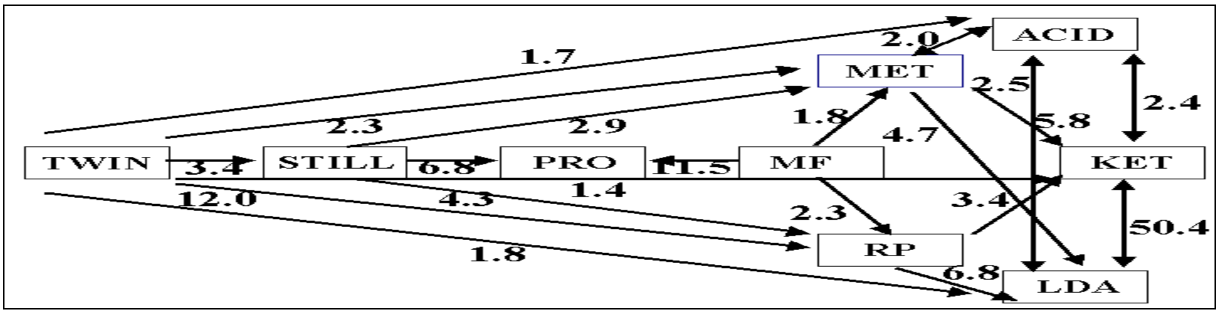
Diseases are multifactorial and call for a "multifactorial approach"

Most production and infectious diseases are multifactorial as well illustrated in Figure 1 that describes the associations among postparturient diseases and traits in terms of summary odds ratios.



TWIN=twins; STILL=stillbirth; PRO=prolapsed uterus; MF=milk fever; MET=primary metritis; RP=retained placenta; ACID=aciduria; KET=ketosis; LDA=left displacement of the abomasum (after Markusfeld, 1987)

Figure 1. Interrelationships among calving traits in terms of odds ratios (8521 lactations)

Control of Production Diseases often involves various disciplines and therefore calls for a "multivariate approach". Such an approach, centered on the herd, had led to the adaptation of integrated programs of herd health. Details of the Israeli Program are found elsewhere (Markusfeld-Nir 1996).

To cross the line from individual to herd medicine, data should be recorded and processed, so that both statistical and epidemiological evaluations can be carried out. Herd health monitoring is done on populations, not on individuals. Individual cow data are yet essential if interactions between factors are to be clarified. Achieving optimal cow performance by drawing operational conclusions from data is the ultimate aim of such a program.

Herd health analysis, has been continuously evolving process, in which we addressed the following questions: **what happened → why it happened → what were losses in production and fertility → how much did it cost us?**

Analysis of calving, reproduction, and production data

We carry out routine monitoring and analysis of health, fertility and production. Relevant data are processed and reports are issued and evaluated, the procedure is described in Fig. 2. The reports include both monitoring and causal analysis.

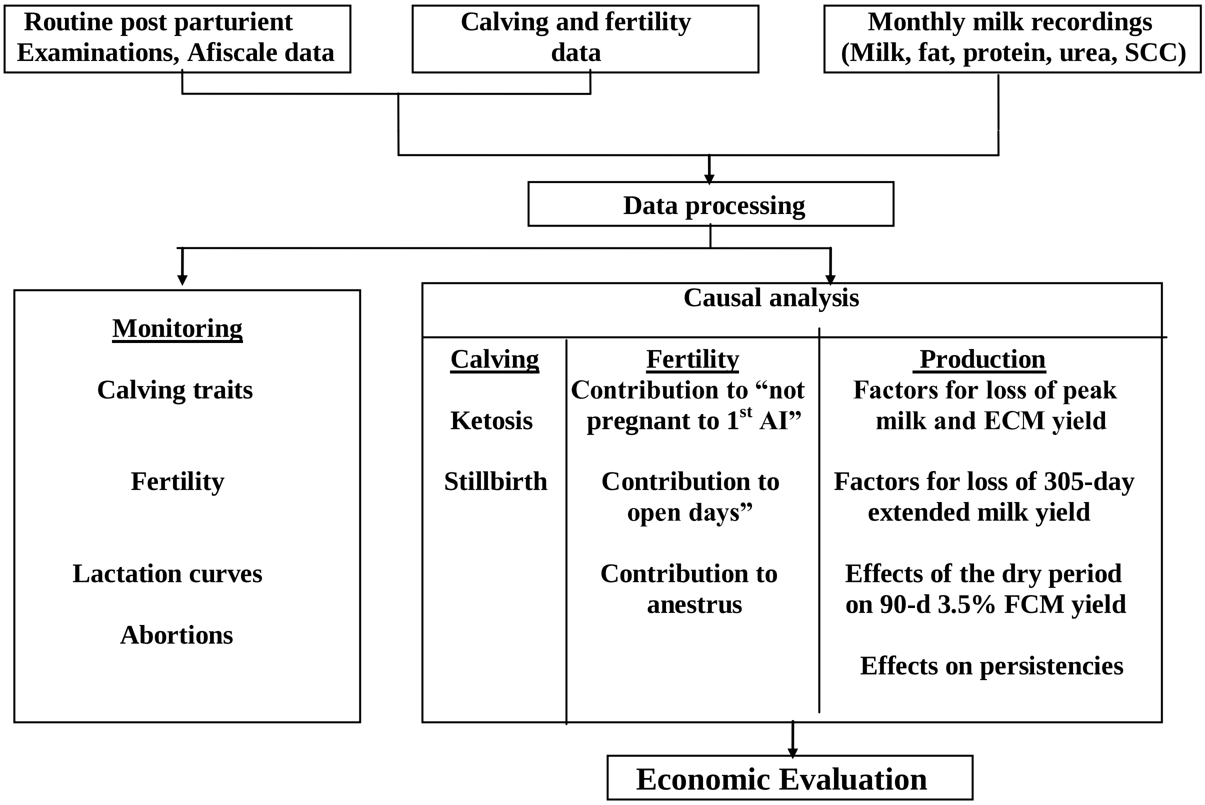


Figure. 2. Routine data analysis and reports

Monitoring reports

Ongoing monitoring of herd performance is compared to preset targets of performance. Targets are used as a challenge for farmers, they should be within reach and updated regularly. We use two types of targets in our reports: a) the best quartiles; and b) desired goals. As an example, we used targets to influence the length of the dry period in the national herd after routine causal analysis showed that dry periods shorter than 60 days adversely affected production in most herds. Dry periods had become longer after resetting the target for their lower limit from 55 to 60 days in 1993 (Table 1).

Table 1. Resetting goals for dry periods (15,570 first lactations' cows)

	1990	1992	1994	1996
Mean length of dry period, days	59	58	62	64

We adjust our targets to the changing conditions. When body condition scoring (**BCS**) became a common practice (Markusfeld et al, 1997) we studied the combined effect (interaction) of the length of the dry period and body condition score at drying off on future production (Fig. 3). The combined effects of short dry periods and low **BCS** at drying off resulted in lower production in the next lactation (mainly in terms of fat) independent of the two separate effects. The interaction implies that cows with low **BCS** at drying off will benefit from a longer dry period and vice versa. Drying off according to **BCS** is therefore now recommended.

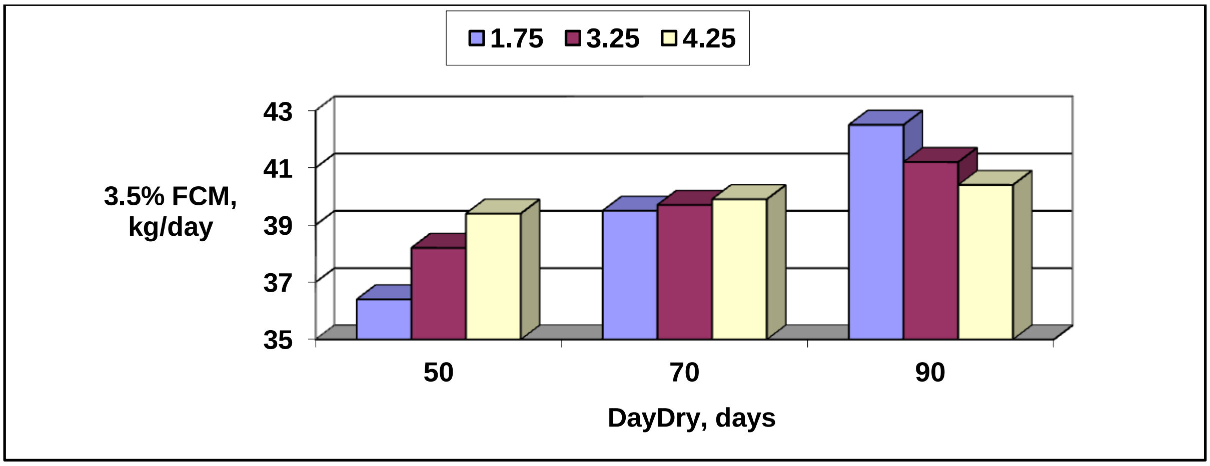


Figure 3. Combined effect of the length of the dry period and body condition score at drying off on future production (3659 multiparous cows in seven herds, source: Nir-Markusfeld 2003).

With recent tendency to shorten the dry period we now routinely evaluate the economic outcome of late drying off of "thin" cows (with BCS of below 3.25 units) taking into account extra yield in the present, and loss of milk (if any) in the next lactation respectively. Such evaluation of the individual herd often proves that late drying off leads to a loss of income (Table 2)

Table 2. Loss of income due to late drying off of "thin" cows

Milk yield of 79 "thin" second lactations' cows		
	dried too late	**dried on time**
Extended 305-d milk, kg	11,507	12,228
Difference, kg	-722*	
loss of income (MXN)[a]	**77,948**	
Milk yield of 97 "thin" third or more lactations' cows		
	dried too late	**dried on time**
Extended 305-d milk, kg	11,924	12,819
Difference, kg	-895*	
loss of income (MXN)[a]	**106,694**	

**p<0.05; [a]Israeli prices in MXN*

A partial monitoring of calving traits is presented in Table 3. We routinely issue monitoring reports that deal with calving traits and diseases, reproduction, lactation curves and abortions. The latter also includes a multifactorial analysis that controls the effects of lactation number, trimester of pregnancy, sire and calendar months (Markusfeld-Nir 1997).

Table 3. Partial monitoring of calving traits for the period 01/03/04-28/02/05

Calving traits	Primipara		Multipara	
a. Total calved	**306**		**510**	
b. % Twins	1.0	(0.7)	6.1	(4.9)
c. % Stillbirth	8.1	(4.8)	5.6	(4.6)
I. % Ketosis	27.7	(7.0)	21.8	(12.0)
j. % Calved with mastitis	0.0	(1.0)	0.0	(5.0)
k. % With DAYDRY >70 d			11.2	(15.0)
l. % With DAYDRY <60 d			31.4	(15.0)
p. Changes of BCS in the dry period (n examined)			461	
1. % Lost ≥0.50 units			20.8	(15.0)
2. % Gained ≥0.25 units			33.6	(15.0)

Values in parenthesis are targets; *denotes values short of targets.*

From monitoring to Causal Analysis, unrevealing the "Local Truth"

Although we manage dairy herds with routines derived from universal experience and published scientific studies, there is no **"Universal Truth"**, but each herd has its own **"Local Truth"** as shown in Table 2 above. We apply routine causal analysis based on regression models on data collected from individual herds in order to expose their "Local Truth".

We evaluate the contribution of various factors to lower fertility and milk yield in the individual herds, presenting the results for first, second and third or more lactations' cows in separate sections.

Table 4. Factors responsible for loss of milk (kg) in the Sample Herd

lactation	**First**		**Second**		**>Second**	
305_d exteneded milk yield	**with**	**9,225**	**with**	**12,004**	**with**	**12,303**
total	**factor**	**260**	**factor**	**238**	**factor**	**213**
calving diseases	193	-352				
summer calvings	145	-732	144	-837	114	-962
low BW at calving	41	-242	21	-504		
high BW at calving			39	314		
dry period >70 days						
dry period <60 days						
Dried off not according to BW			29	-722	32	-895
Lost >50 kg in the dry period			72	-632	75	-539
mastitis						
young						
old						
induction						

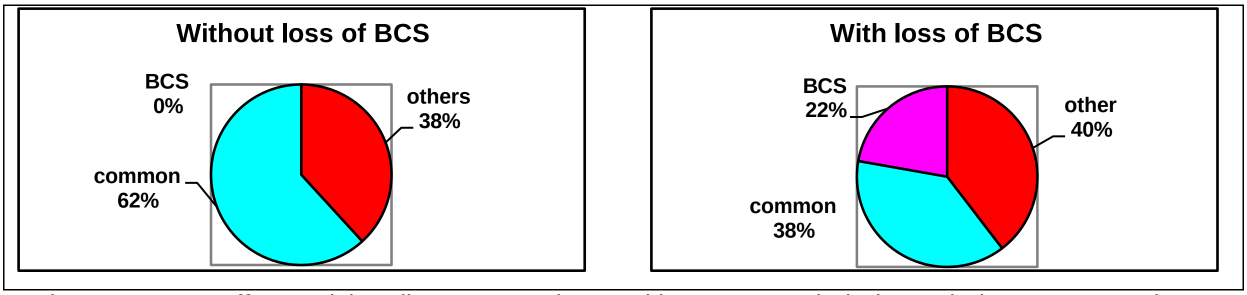
p for all values <0.1

Five different models evaluate factors affecting a) milk; and b) economy corrected milk (ECM) peak yields; c) extended 305-d milk yield; d) daily 3.5% FCM in the first 90 days in milk; and e) persistencies. Table 4 sums the factors affecting extended 305-d milk yield in our Sample Herd.

Three different models evaluate factors responsible affecting fertility: a) Contribution to "non pregnancy to first service"; b) Contribution to unobserved heat; and c) Contribution to open days.

Improving the analysis by introduction of new variables

Additional variables, when added to the models could reduce the “common” unknown factors. Figure 4 illustrates the reduction in the contribution of the "common factors" to the trait “not pregnant to first AI service” when the factor “**loss of BCS before AI service**” is added to the logistic regression model.



Others=summer effect, calving diseases, unobserved heat, rest period, dry period; Common=unknown factors (the constant); ***BCS****=lost >0.5 units BCS from calving to 55* ***DIM***

Figure 4. “Non pregnancy to first AI service”, Reduction of the unknown “Common factors” by adding “Loss of BCS before AI” to the model

Data analysis and quality of the data

Advanced statistical methods could not take the place of complete and reliable data as illustrated in Table 5. In the hypothetical example that evaluates contributions to peak milk yield, uterine diseases in the "partial data" set include only cases of retained placenta, while in the "complete data" set they include both cases of retained placenta and primary metritis (with no history of retained placenta). When not all cases of metritis were included (“partial data”), cows with metritis produced more milk than cows without the disease. The significance of this example could not be underestimated considering the common practice where cows are not examined routinely after calving.

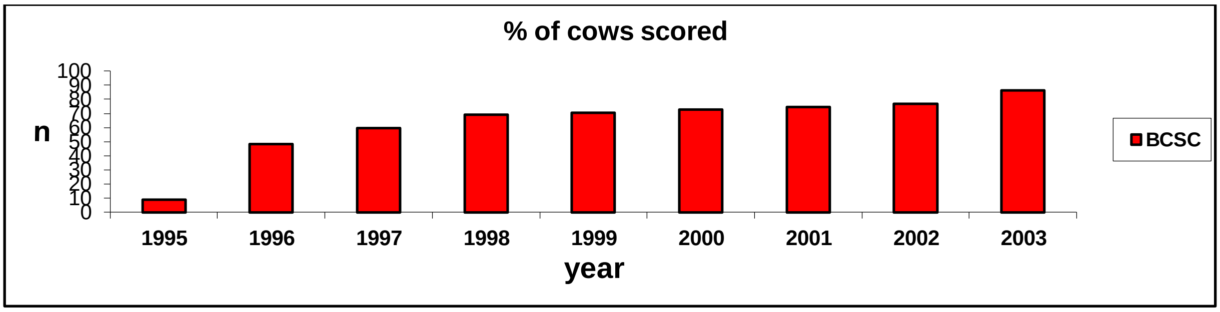
Table 5. Incomplete (hypothetical) data in second lactations’ cows - Estimates of changes in peak milk yield, kg

	Complete data		Partial data[a]	
	Incidence or quartile	Milk changes	Incidence or quartile	Milk changes
Uterine diseases	**37.1**	**-2.2***	**10.3**	**4.0***
Summer calvings[b]	35.1	-2.8*	35.1	-2.3*
Low BCS at calving[c]	3.00	0.7	3.00	-0.2
Short dry period[c]	**61.0**	**-3.0***	**61.0**	**-3.9****

*p<0.05 **p<0.01; [a]Not all cases of metritis are included; [b]Calving period April through August; [c]Lowest quarter.*

Feedback to farmers encourages production of better data

Improved models and the growing economical benefits derived from them encourage farmers and veterinarians to produce, collect, and record more data that in turn lead to better understanding of health problems in a given herd. This is illustrated in Figure 5 that shows the growing number of cows that are body scored after calving in Israeli herds involved in the integrated herd health program.



***BCSC**=**BCS** at calving;*

Figure 5. Percentage of Israeli cows in the integrated herd health program that are body scored in the various stages of the lactation (200 herds in 1995, 245 herds in 2003)

Economic evaluation

Table 6. Evaluation of loss of income due to diseases and managemental mistakes

What did we loose money for (MXN)? - Israeli prices			
Sample Herd	**milk**	**fertility**	**total[1]**
Summer calvings	802,161	0	802,161
long or short dry periods	176,117	27,393	203,509
Lost BW in the dry period	308,463	0	308,463
Over- or under-conditioned at calving	163,381	0	163,381
Calving diseases	253,058	0	395,978
NEB at calving	0	0	0
NEB at AI	0	143,400	143,400
Unobserved heat	0	97,594	97,594
Long rest period	0	209,617	209,617
Replacements & structure of herd	0	-57,947	174,890
Mastitis	118,941	0	118,941
Abortions	0	62,209	835,966
Total	**1,822,135**	**482,265**	**3,453,913**

[1]includes other expenses **11.8% - of the estimated income from milk**

We have expanded recently our models to present the results of the causal analysis in terms of financial losses. Economic interpretation allows farmers to set priority to their resources and investments according to the expected returns. Such evaluation is presented in Table 6, the example is taken from an Israeli sample herd, the prices are Israelis, and in MXN. Losses of income that could be attributed to diseases and managemental factors identified in the Herd Health Report amounted to 3,453,913 MXN (11.8% of the estimated income from milk in the period analyzed).

From manual observations to automation

More automation will lead to better data, both in quantity and in quality. **Afimilk©** system has already many automated components that replaced, partly or completely the need for manual observations (milk recording, milk conductivity, and pedometers).

Body condition scoring (**BCS**) of dairy cows in various stages of the lactation is the most important tool used to evaluate energy balance of cows over the lactation in the field. The two major handicaps of **BCS** are its low objectivity and resolution (0.25 units in a scale of 1 to 5). **AFISCALE©** is an automated scale, which is an integrated part of the **AFIMILK©** system. We are using body weight (**BW**) data derived from the Afiscale© in our models, the results show that **BW** can replace **BCS** in the models evaluating the effects of **NEB**, not only when differences between **BW** in the various stages of lactation are calculated, but also when stand as a single measurement. Table 7 compares two multiple logistic regression models for ketosis after calving, in data taken from 1424 lactations in eight different herds. The models evaluate the effects of established risk factors on ketosis; the two models differ from each other in one of the risk factors (**BCS** ≥3.75 units and the highest quarter of **BW** at drying off respectively). The two models show similar results.

Table 7. Summary of multiple logistic regression analyses for ketosis (1424 lactations of multiparous cows in eight Afifarm herds.

	Summer Calvings	**Dry period >70 days**	**Calving diseases**	**BCS ≥3.75**	**BW[b]**
Odds Ratio[a]	1.7**	1.1	3.1 **	**2.3****	
Odds Ratio[a]	1.6**	1.3	2.7 **		**3.9****

***p<0.01; [a]to suffer from ketosis compared to a cow without the examined factor; Effects of parity were included; [b]Body weight at drying off over 718 kg (upper 25%tile)*

Efforts to develop other automated substitutes to manual data are going on; the results of some will be incorporated in the Afimilk© system in the coming two years. On-line analysis of milk fat and protein is now in the final stages of evaluation, association of **NEB** with milk solids is described elsewhere (Nir-Markusfeld, 2004). Other progress in automation is expected in the ability to analyze on line progesterone and ketones, optic measurements of body height of heifers.

Multidisciplinary causal analysis

The introduction and assimilation of systems approaches into the education of animal and veterinary scientists, and the development of whole herd models talking into account production, health and fertility will be essential to achieve a better multidisciplinary balance in the future. This urgent need is not easy to satisfy, considering the present state where models evaluating health are based on **within herd**, while those evaluating nutrition on **among herds'** differences.

Conclusions

Routine health reports based on epidemiological models are today a common tool used by farmers, veterinarians and nutritionists in Israel and in some other countries. Though experts prepare the reports, their improving quality is the result of routine practice evolved through understanding of the multifactorial nature of modern veterinary issues. Through their postgraduate training, most practicing veterinarians are capable of reading the reports, interpreting them and implementing the conclusions in their practice. The speaker believes that future progress in applied epidemiology will be in three main fields a) improvement of data through automation; b) development of multidisciplinary models including economical evaluations and c) improvement of methods applied to small herds.

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