Achieving Optimal Cow Performance with the Aid of Information

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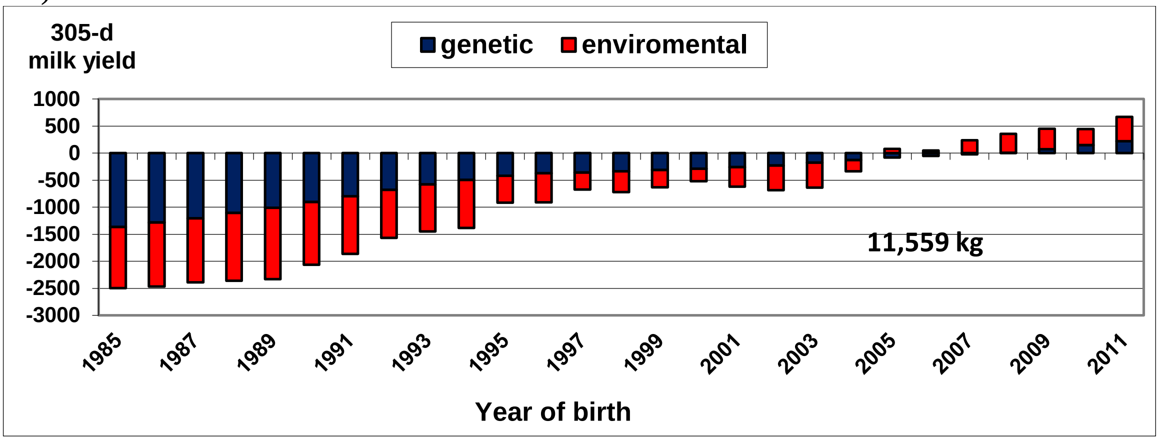
Ezra (2012) evaluated the relative contributions of genetic and managemental components to the phenotypic increase in **milk yield** in Israeli Holsteins (Figure 1). The yield in the reference year (2006) was 11,559 kg,

Figure 1. Israeli Holstein - Phenotypic increase of milk yield according to year of birth (Ezra, 2012)



The environmental increase had been the outcome of continuous joint efforts of farmers, scientists, nutritionists and veterinarians working in harmony. The success of all those efforts could be largely related to the available comprehensive data, largely formed and collected through the Herd Health Program, practiced in Israel.

Information systems in the dairy herd are used for **planning, management, follow-up & control**. Herd data analysis, is a continuously evolving process, in which we need to address the following questions: a) retrospective monitoring (**what happens?**); b) retrospective evaluation of causality and economical losses (**why did it happen? what were the losses in production and fertility? what were the economical losses?**); c) diagnosis and alert (**what will happen?)**.

Veterinary medicine had traditionally centered on individual animals. Emerging new problems being mostly multifactorial and multidisciplinary called for integrated programs for herd health. 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; the concept is described in Figure 2.
Ongoing monitoring of herd performance is compared to preset targets of performance. Monitoring reports alert against any fall from preset targets, and as such should be short, concise, engulf all aspects of herd health and issued at regular times. Shortfalls should be further investigated using epidemiological methods. 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 updated annually; and b) desired goals. We routinely issue monitoring reports that deal with production, 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. An example of a partial monitoring of calving diseases and traits are described in Table 1.

Figure 2. The dairy Herd Health Program. The concept

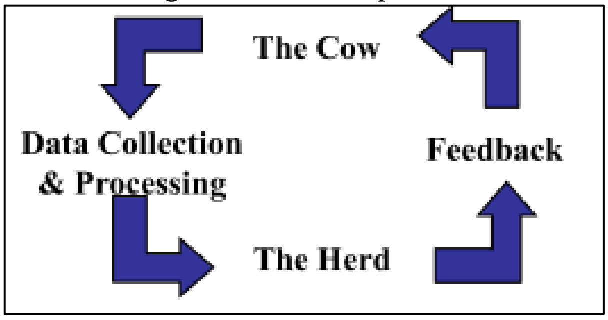


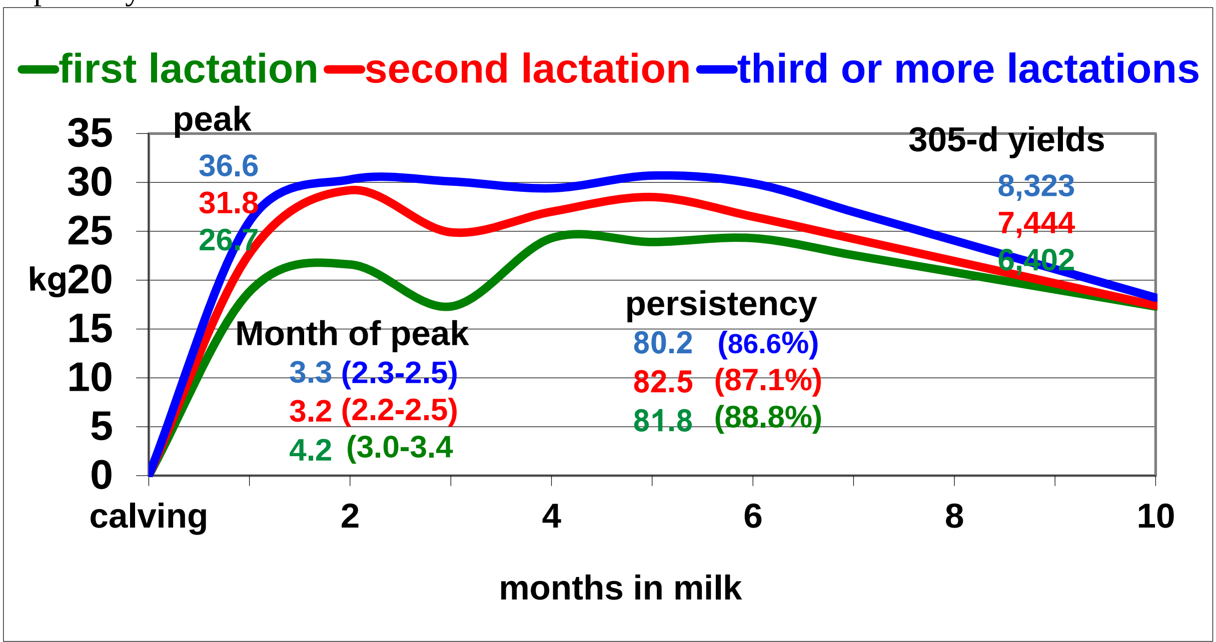
Table 1. Monitoring, calving diseases & traits (partial)

p1	Calving Period: 09/05-08/06			
Calving traits	**Primipara**		**Multipara**	
a. Total calved	**159**		**264**	
b. % Twins	**0.0**	**(0.0)**	**6.4**	**(5.1)**
c. % Stillbirth	**10.2**	**(4.7)**	**10.0**	**(4.3)**
d. % Milk fever	**0.0**	**(0.0)**	**5.7**	**(1.6)**

Values in parenthesis are "targets"

The lactation curves of a SA pasture herd, is described in Figure 3. Cows were erroneously fed additional concentrates according to their expected yield. Upon correcting the ration cows had secondary peaks.

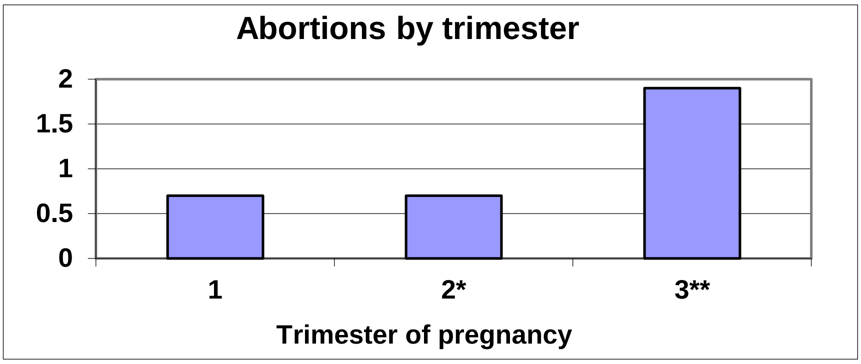
Figure 3. Monitoring Lactation Curves, SA Pasture **(™*AfiFeed*)**. Cows fed according to expected yield



Values in parenthesis are "targets"

Figure 4 describes the risk of abortions by trimester for a period of one year in a herd. 150 losses of embryos were recorded in the period. (5.0 per 10,000 cows-days-at risk; 7.7% proportion of aborted cows, 1 aborted twice). Risk of abortion was higher in the third trimester was 1.9 times as much compared to all other trimesters pooled together (allowing for the effects of parity, calendar months and sires).

Figure 4. Abortions in a herd. A third trimester abortion profile associated with Leptospira hardjo.



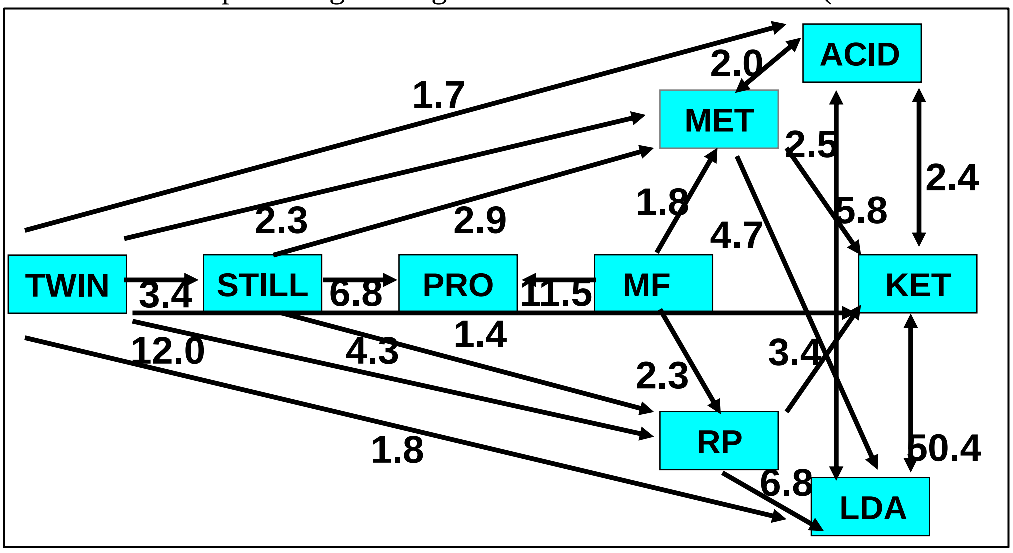
*p<0.05; **p<0.01

Most abortificients are trimester specific; establishing the odds risk aborting in any one trimester of pregnancy might direct the clinician to more efficient laboratory diagnosis. In our sample herd we concluded that brucellosis, chlamidiosis, leptospirosis, salmonellosis, listeriosis, nitrates, Vibriosis or IBR could not be ruled out as the factors responsible (Leptospira hardjo proved eventually to be the abortifacient involved).

Diseases are multifactorial and call for a "multifactorial approach"

Most production and infectious diseases are multifactorial, and, therefore, call for a ‘multifactorial approach’ (Nir-Markusfeld, 2008). Figure 5 describes the associations among postparturient diseases and traits in terms of summary odds ratios (p of all associations <0.01).

Figure 5. Interrelationships among calving traits in terms of odds ratios (8521 lactations).



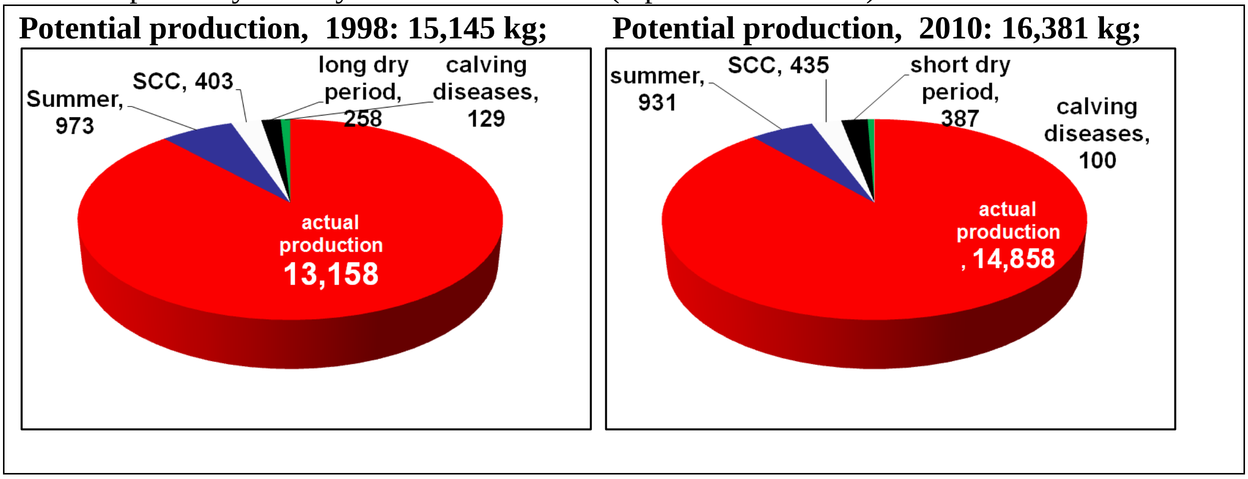
TWIN=twins; STILL=stillbirth; PRO=prolapsed uterus; MF=milk fever; MET=primary metritis; RP=retained placenta; ACID=aciduria; KET=ketosis; LDA=left displacement of the abomasum (after Markusfeld, 1987)

Revealing the local truth

Although we manage dairy herds with routines derived from universal experience and published scientific studies, **there is no ‘universal truth’; each herd has its own ‘local truth’**.

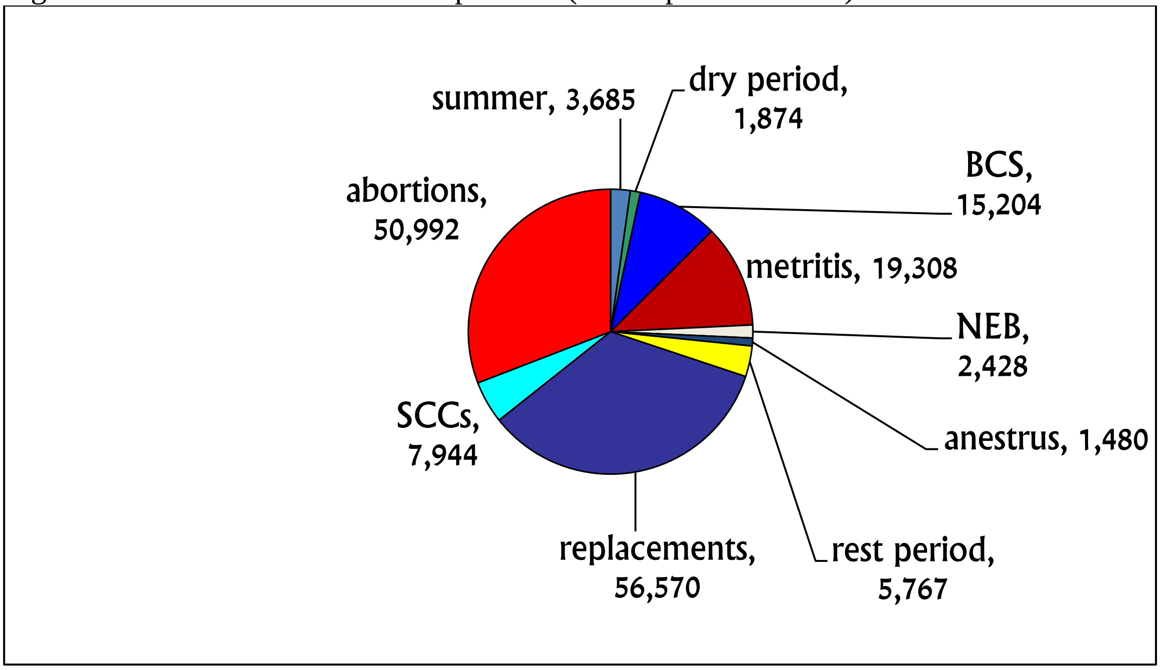
Correcting managemental mistakes and reduction losses attributed to diseases
We apply routine causal analysis based on regression models on data collected from individual herds in order to expose their 'local truth' and to evaluate the contributions of various factors to lower fertility and milk yield in the individual herds.
Figure 6 illustrates the potential contribution of correcting managemental mistakes and diseases to milk yield by adding the amounts lost due to various factors to the actual yield.

Figure 6. Estimated 305 days potential & actual milk yield. 868 & 1406 3rd or more lactation cows respectively in the years 1998 and 2010 (top 10 Israeli herds).



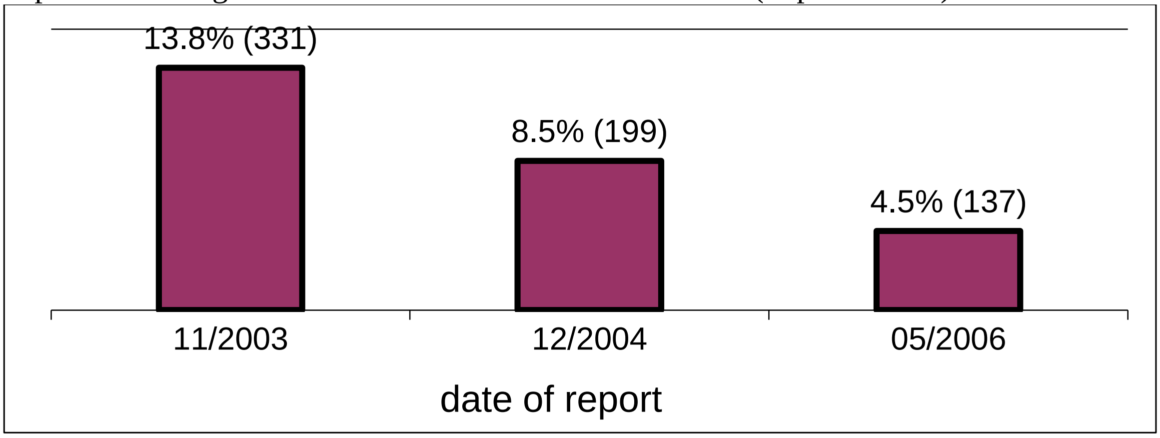
We have expanded our models to present the results of the causal analysis in terms of financial losses. Economic interpretation allows farmers to set priority to their resources and investments according to the expected returns. Such evaluation is presented in Figure 7, the prices are Israelis, and in Euro. Losses of income that could be attributed to diseases and managemental factors identified in the Herd Health Report amounted to **€ 165,251** (**11.5%** of **the estimated income from milk in the period analyzed)**.

Figure 7. Estimated losses in a sample herd (Israeli prices in Euro).



The economic progress in an Israeli herd H. is illustrated in Figure 8. The estimated annual losses of income attributed to diseases and managemental mistakes expressed as % of income from milk and in (1000 €) respectively.

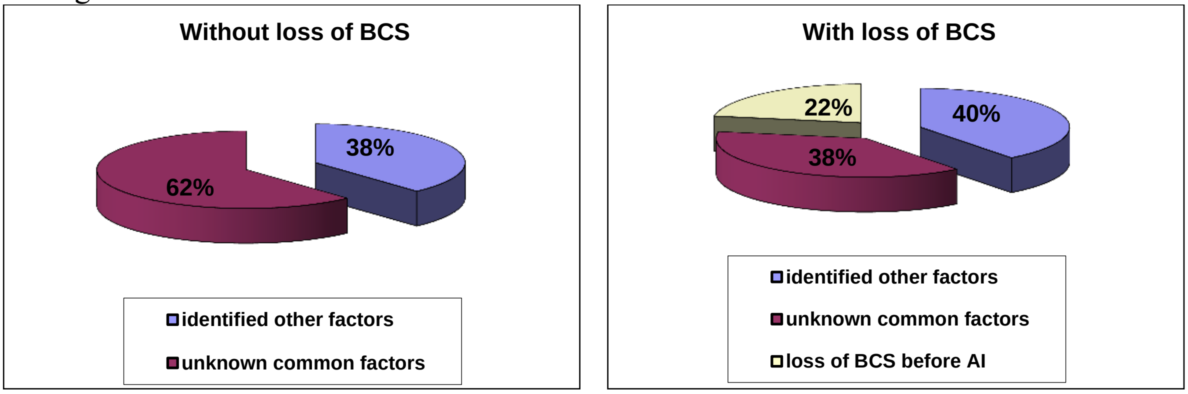
Figure 8. The economic progress in the Israeli herd H. (2003 through 2006). Annual losses are expressed in %age of income from milk and in 1000 Euro (in parenthesis)



Improving the analysis by introduction of new variables

Additional variables, when added to the models could reduce the 'common' unknown factors and allow for a better management. Figure 9 illustrates the reduction in the contribution of the **'common factors'** to the trait '**not pregnant to first service'** when the factor **'loss of BCS before service'** is added to the logistic regression model.

Figure 9. Non pregnancy to first AI service. Reduction of the unknown 'common factors' by adding 'loss of BCS before service' to the 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 50 days in milk (**DIM**).

Quality of data

Advanced statistical methods could not take the place of complete and reliable data as illustrated in Table 2. In the hypothetical example, the various contributions of metritis to "loss in peak yield" are illustrated. When not all cases of metritis were diagnosed ("partial data") cows with metritis produced more milk than cows without the disease. The estimates are different when the complete data set is used, and the "healthy" population does not include hidden cases of metritis.

Table 2. Incomplete (hypothetical) data in second lactation cows. Estimates of changes in peak milk yield (kg).

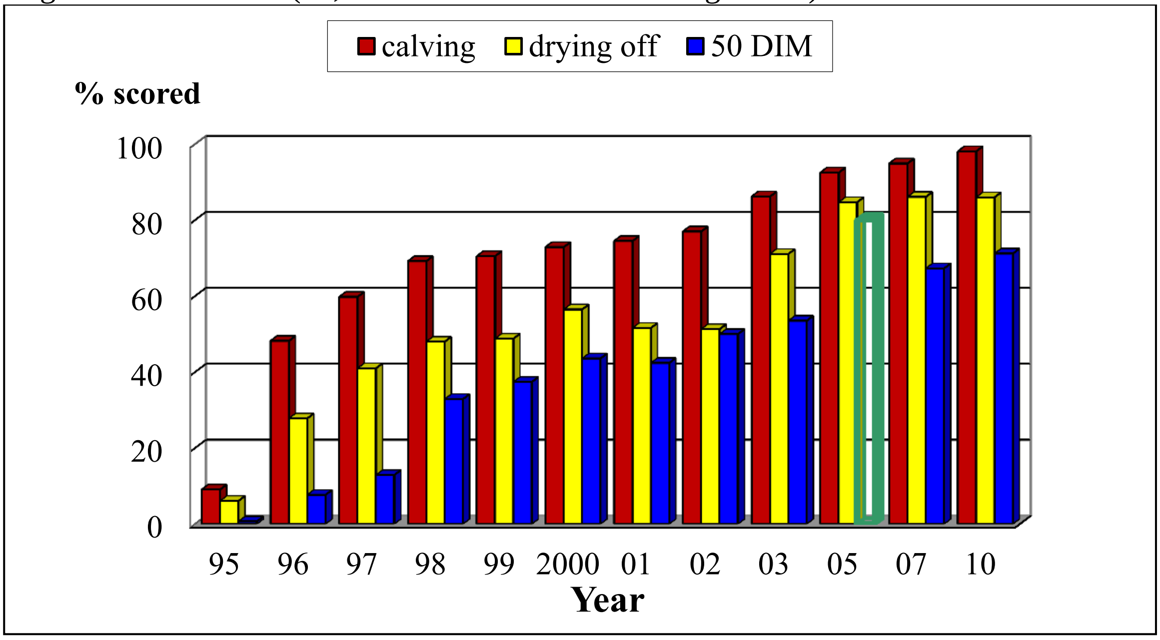
	Complete data		Partial data	
	Incidence or quartile	Milk lost#	Incidence or quartile	Milk lost#
Calving diseases	**37.1**	**-2.2***	**10.3**	**4.0***
Summer calvings[a]	35.1	-2.8*	35.1	-2.3*
Low BCS at calving[c]	3.00	0.7	3.00	-0.2
Short dry period[c]	**61.0**	**-3.0***	**61.0**	**-3.9****

[a]*Calving period April through August (15th October in seasonal herds).* [c]*Lowest or highest quarter. # Compared to cow without a factor. *p<0.05 **p<0.01*

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 10 that shows the growing number of cows that are body scored three times during the lactation in Israeli herds involved in the integrated herd health program.

Figure 10. Percentages of Israeli cows in large dairy herds that are body scored in the various stages of the lactation (40,379 cows in 163 herds through 2010)

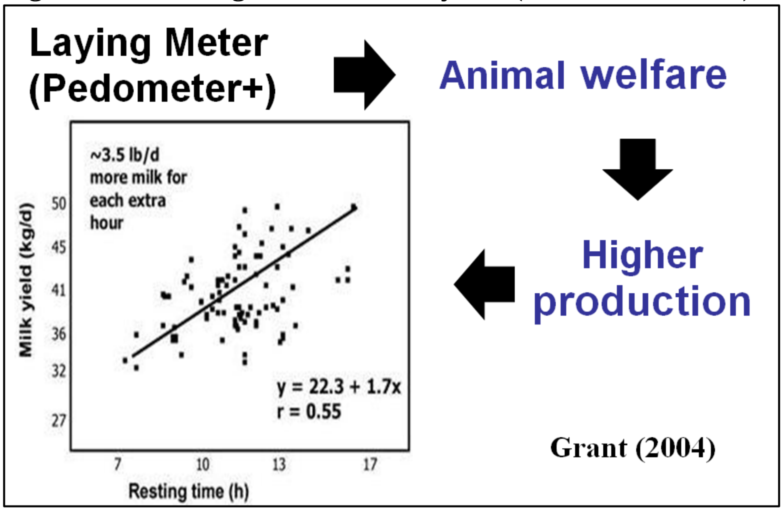


From manual observations to automation

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, pedometers and automatic scaling). More automation is taking place, the applications of some are now being incorporated in the **Afimilk©** system. Two are presently described.

Pedometer+™ - is a new leg tag that continuously records activity (number of steps), lying time and lying bouts. It is based on a 3 dimensional sensor which detects the position of the animal leg. The concept is to determine the routine behavior of the animal (at individual, group and herd levels) and to define deviations from the daily routine. Such deviations are potential indications for welfare, health, fertility, production and stressful events (Figure 11). Applications are now under study and implantation.

Figure 11. Resting time and milk yield (after Grant, 2004)



Applied studies for uses of the behavioral meter showed that behavioral data collected and analyzed may be used as a useful tool for evaluation and detection of stressful situation (e.g. heat stress, noise disturbance, bedding condition). Derived applications would be monitoring housing management, influence of alteration in farm routine or facilities and prediction of calving time (Arazi, 2008).

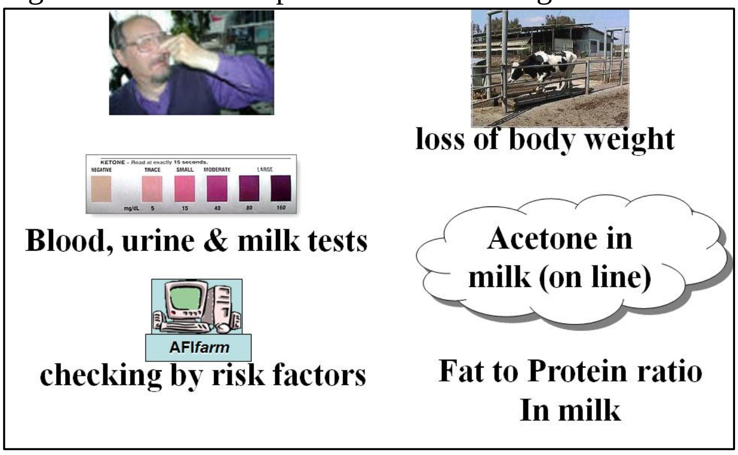
Afilab^{TM} - is an in line - on line milk analyzer that performs real-time analysis of individual cow milk solids (fat, protein and lactose) and gives indication of blood in every milking .The technology is based on spectroscopy, therefore it does not interfere with milk flow through the line nor does it alter the milk in any way (clean measurement).

From retrospective analysis to prediction, screening & diagnosis

Ketosis (acetonemia) is metabolic disorder of carbohydrates and saturated fatty acids, associated with hypoglycemia and an elevation of ketone levels in the blood, milk and urine. The disorder manifests a state of a negative energy balance (**NEB**) and is associated with either clinical or sub-clinical disease.

Common practices to diagnose ketosis include the “smeller” (for clinical cases); blood, urine and milk tests for **BHBA**; checking by risk factors; and loss of body weight (Figure 12). While checking acetone in milk on line is still a dream, models based on milk fat to protein ratio (**FPR**) have been introduced to the dairy practice.

Figure 12. Common practices used to diagnose ketosis



Because milk fat concentration tends to increase and milk protein concentration tends to decrease during the postpartum negative balance, the fat to protein ratio was suggested as a

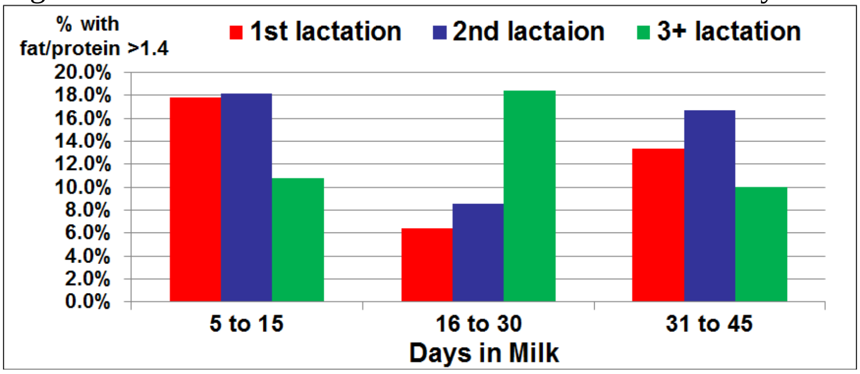
potential indicator of a lack of energy supply through feed (Grieve et al, 1986). Heuer et al (1999) suggested that similar associations could be derived from regular milk control data. Regular milk tests allow establishing the rate of cows with **FPR**>1.4 and drawing the profile of the **FPR** for each individual herd classified by parity and stage of lactation ("early or late ketosis").
Table 3 & Figure 13 describe the level and mode of **NEB** in an Israeli herd #2. Rates of diagnosed (**and treated ketosis**) are low for cows of all lactations, while those of **FPR**>1.4 are moderate.

Table 3. Rates of diagnosed ketosis in Israeli herd #2. All cows routinely checked for ketosis 5 to 12 days postpartum. Checking is by smelling.

Calving traits	First lactation		≥Second lactation	
a. Total calved	224		712	
i. % with ketosis	1.4	(8.3)	4.6	(14.0)

Values in parenthesis are "targets"

Figure 13. Rates of cows with FPR>1.4 in Israeli herd #2 by lactation and days in milk (**DIM**)



It can be concluded that the routine postpartum examination carried out on all cows 5 to 12 **DIM** in herd #2 was of no value in detecting ketotic cows due to a) of the method (smelling); and b) the mode (cows suffered from **NEB** up to 45 **DIM**).

Table 4 & Figure 14 describe the level and mode of **NEB** in a Portuguese herd. Rates of diagnosed (**and treated ketosis**) are very low for cows of all lactations, while those of **FPR**>1.4 are very high for cows of 3rd or more lactations.

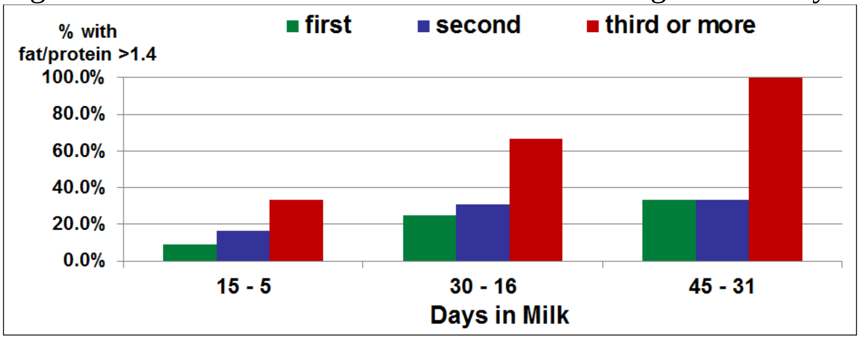
Table 4. Rates of diagnosed ketosis in a Portuguese herd. No routine check for ketosis is practiced.

Calving traits	First lactation		≥Second lactation	
a. Total calved	82		61	
i. % with ketosis	0.0	(8.3)	1.7	(14.0)

Values in parenthesis are "targets"

It can be concluded that without routine postpartum (almost) all ketotic cows are undiagnosed and mot treated. Value of a routine check for ketosis of all calving cows will be limited because of the late mode of the late **NEB**

Figure 14. Rates of cows with FPR>1.4 in a Portuguese herd by lactation and (**DIM**)

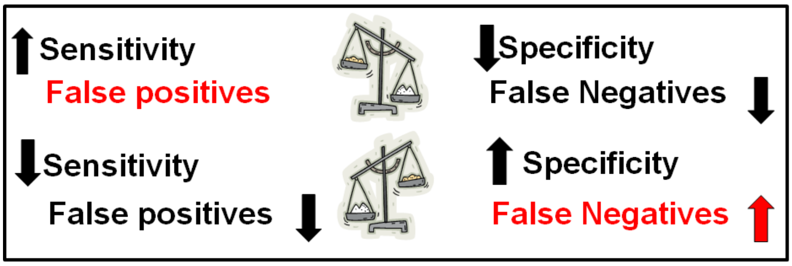


Diagnosis of Ketosis with the Afilab™

Diagnosis of ketosis with **FPR** and the **Afilab™** is a biological challenge for the following reasons: a) **FPR** is a continuous variable (scale), for diagnosis a clear cut point (threshold) is needed; and b) reproducibility, repeatability, reliability are problematic due to variations in biologic values

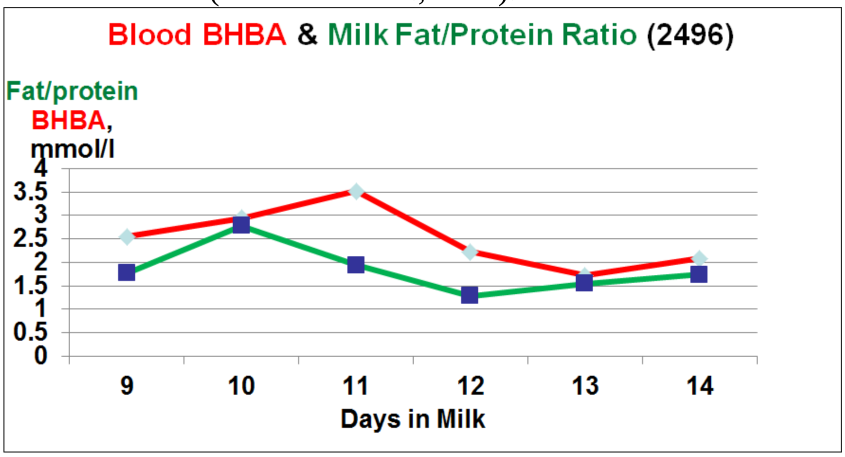
Various thresholds of **FPR** & **BHBA** were suggested for the diagnosis of clinical and sub clinical ketosis. The difficulties associated with the level of the threshold are described in Figure 15, and those with the biological variations in Figures 16 & 17.

Figure 15. The conflicting specificities and sensitivities with various thresholds of **BHBA** and **FPR.**



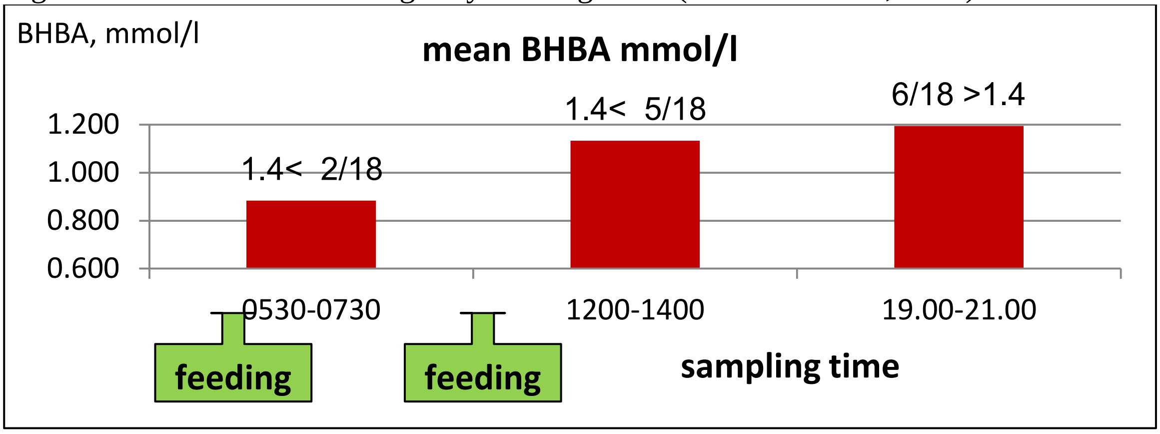
In a trial of induced ketosis in five cows (Schcolnik et al, 2009) there was no synchronization between peaks of **BHBA** & **FPR**, the relative curves of cow #2496 is in Figure 16.

Figure 16. The absence of synchronization between **BHBA** & **FPR** in cow #2496 after induced ketosis (Schcolnik et al., 2009).



Blood BHBA also changes by feeding time (Schcolnik et al, 2012). Noon & evening means were different from that of the morning, means change according to feeding times & ration. Number of cows with **FPR** >1.4 were also different, 2/18, 5/18 & 6/18 in morning, noon, & evening sampling respectively (Figure 17).

Figure 17 Blood **BHBA** Changes by Feeding Time (Schcolnik et al., 2012)



Overcoming the Sensitivity/Specificity conflict & the biological variations with 2 Models (Simultaneous Testing)

We used two models in which the "gold standard" was serum **BHBA** >1.4 mmol/l in **one of the days** from day – 1 to day +1 with **different FPR in 3 consecutive milking sessions**

1. Fat to Protein Ratio >1.4 in all 3 milking sessions **(Red List)**
2. Fat to Protein Ratio >1.3 in one of the 3 milking sessions **(Black List)**

The final outcome is a daily list of cows, 5 to 45 **DIM,** with suspected ketosis.

2682	3201	3336	3704	3746	4015	4038	4302	4352	4354	4371

The detailed results of the field trial involving 134 valid observations are in table 5. In simultaneous testing, sensitivity increases and the specificity decreases, Results of additional field trials vary according the biological variations.

Table 5. Details of two models of simultaneous testing for **BHBA** >1.4

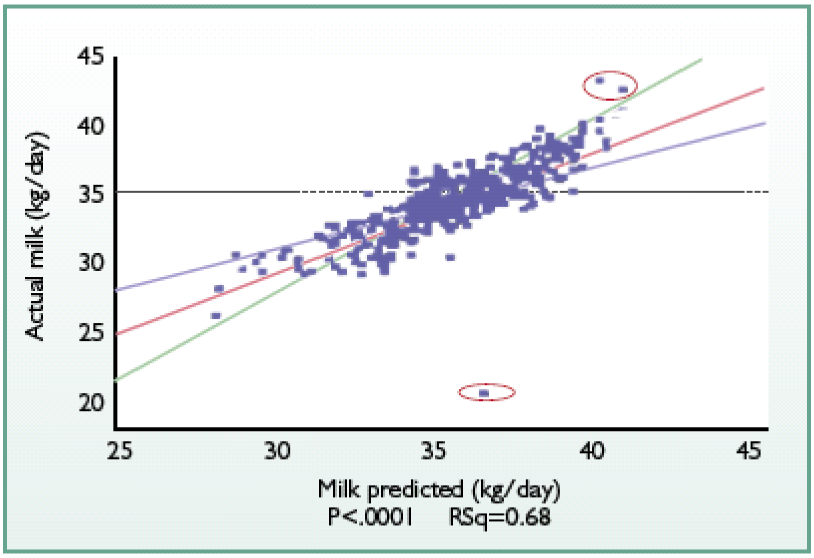
	n	pos%	sensitivity	specificity	posPV	negPV	Kappa coefficient
"Red" model	134	22.4%	53.3%	82.7%	47.1%	86.0%	0.344 (p<0.0001)
"Black" model	134	22.4%	76.7%	58.7%	34.8%	89.7%	0.248 (p<0.0007)

Multidisciplinary and multi- (among) herds' causal analysis: stocking density

Whole herd models, based on **among herds'** differences and talking into account production, fertility, health, nutrition, and economics are called for.

Stocking density, mean days in milk (DIM and somatic cell counts (**SCC**), which are linked, should be addressed simultaneously. While the measures of the last two are objective, it is very difficult to estimate the stocking density. The recommended indexes (22m^2/cow in loose stalls, and 100% cubicles in free stalls) do not necessarily represent the actual stocking density. When we verified that the housing capacity or quality and management of the herd were stable throughout the period analyzed, we calculated the monthly stocking density (density) as percentages relative to the month with the lowest number of cows in milk in the period analyzed. We estimated the independent effects of the density, DIM and SCC on yield (kg) from monthly data of actual marketing in a random sample of 19 herds (382 herd months all together) applying a linear regression model, where we allowed for the effects of the various herds, months, and % of first lactation cows. Figure. 18 compares the predicted milk yields derived from the model to the actual ones. Except from those herd months circled in red the fit was good and allowed us to apply the model to individual herds (Nir – Markusfeld, 2008).

Figure 18. The effects of DIM, SCC and herd density on daily yield (kg/milking cow) in 382 herd months in 19 herds 2006/07.



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The effects of the increasing density on mean daily herd production (**ECM**) and income (**Euro**) using the last milk recording of 11/2007 in an Israeli herd (520 cows in milk) are in Table.6. Culling the 10 marginal cows will increase herd production, while income/cost balance will be reached only after culling 35 such cows.

Table 6. Extra daily **ECM** production and income (Euro) by adding (not culling) marginal Cows to the herd (Herd #D, 11/2007 milk test, 520 cows in milk)

n extra marginal cows	5	10	15	20	25	30	35	40
Extra ECM production, liters/day	-159	-15	153	355	535	732	942	1133
Extra income, Euro/day	-23.8	-34.2	-37.7	-35.5	-29.8	-21.9	-11.0	0.2

Conclusions

To conclude a) herd health problems are multifactorial & multidisciplinary and should be dealt as such; b) Each herd has its own truth; c) obtaining high quality data is essential; d) automation is gradually taking the place of manual collection of data; and e) yet, there is no alternative to hard work!

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