Center for International Cooperation
国际合作中心

Data analysis in a dairy farm

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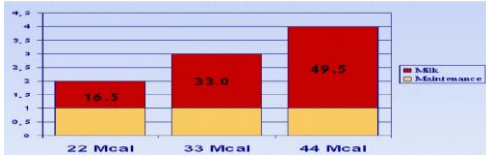
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Dairy farm goals

- The goal of a dairy farm in San Yuan company is to reach high income.
- High income = High milk production
- High milk production could be achieved by:
  - Many cows with low or average milk yield
  - Few cows with high milk yield

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生产性能Herd Performance

- 日均产 **Milk/Cow/Day**
  - 我们的利润来自增加的3－5公斤牛奶
    The cheapest milk a producer can make is the next 3-5 kg each cow produces
    - 固定的成本已经涵盖，除了饲料成本就是利润。
      Fixed costs already covered; only additional associated costs are marginal costs – mostly feed
 - 目标：25－45公斤/天 Goal: 25 – 45 kg/cow/day

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Feed cost for production of 1 kg of milk in San Yuan farms
三元的每公斤奶饲料成本

Milk/d kg 日均产	DMI* kg 干物质采食量	NE l* Mcal/kg 净能	CP* % 粗蛋白比率	Diet Price** ¥ 日粮价格	Cost of 1kg milk ¥ 公斤奶成本
25	20	1.38	14.1	37.6	1.50
35	23.5	1.49	15.2	47.3	1.35
45	26.5	1.55	16	54.1	1.20
54	30	1.62	16.7	63.8	1.18

* NRC 2001 ** December 2010

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The effect of milk yield on production cost
产奶量对生产效率的影响

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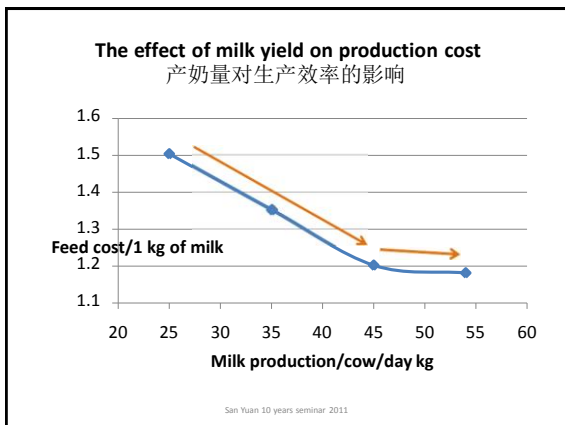
Conclusion #1

- It is better to keep few high producing cows than many low producing cows in order to increase milk production as well as net income.

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Milk yield

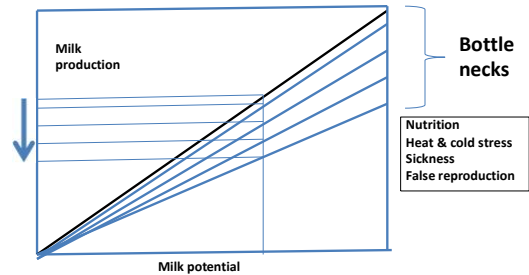**Milk yield =**

genetic milk potential

+

Environmental conditions
- Nutrition
- Climate
- Health
- Reproduction

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The relationship between milk potential and actual milk production

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What data analysis in dairy farm is all about ?

- We run data analysis in order to identify the reasons for a herd not reaching its genetic potential.
- Identifying the influence of the bottle-necks on milk production.

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In order to be able to analyze dairy farm data a DHI* system has to be used

Dairy Herd Improvement

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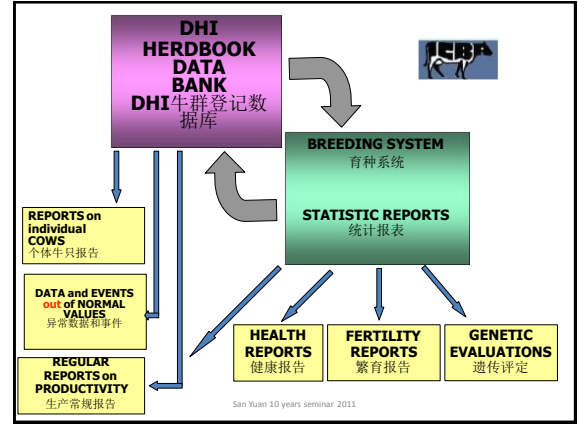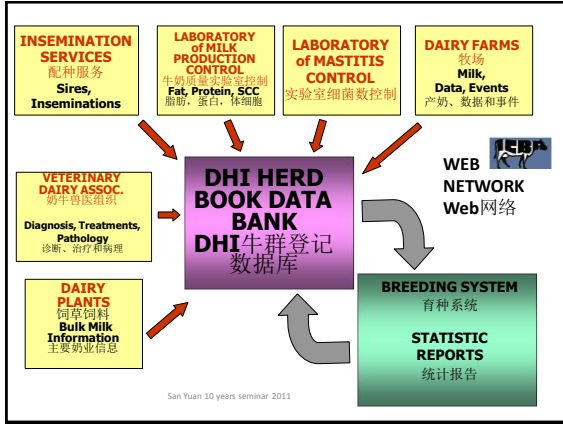

How DHI system works in Israel ?
以色列**DHI**系统是如何运行的？

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THE ISRAELI DHI – HERD-BOOK
以色列**DHI**牛群登记

- **Registration of bulls and cows**
- 牛只注册（包括公牛）
- **Data recording (input)**
- 数据记录（录入）
- **Data validation (logic tests)**
- 数据校验（逻辑校验）
- **Data processing (statistical analysis)**
- 数据处理（数理统计）
- **Genetic evaluation**
- 遗传评估
- **Special professional production reports (output)**
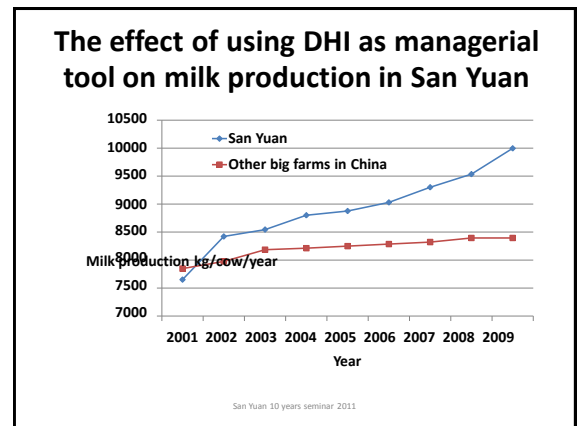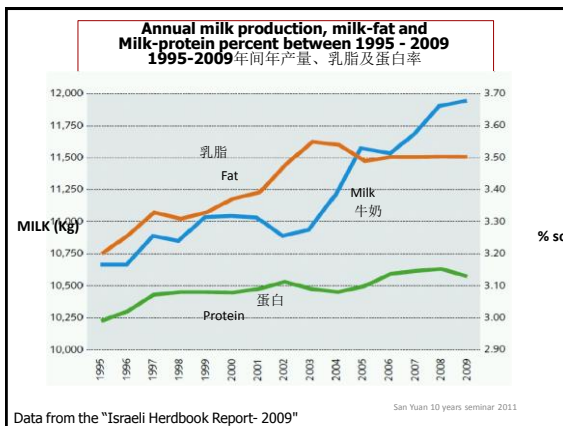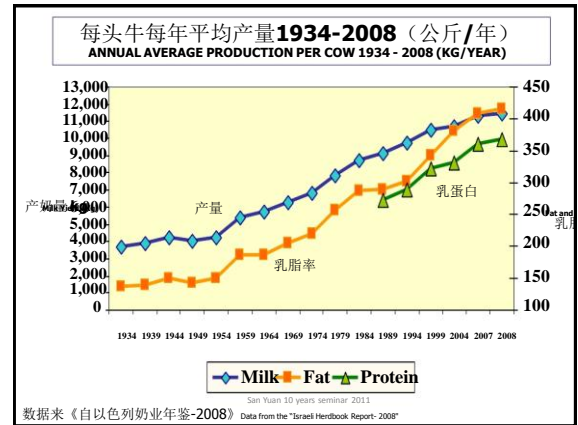- 专业化生产报告（输出）

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Slide 1

| INSEMINATION SERVICES 配种服务 Sires, Inseminations | LABORATORY of MILK PRODUCTION CONTROL 牛奶质量实验室控制 Fat, Protein, SCC 脂肪，蛋白，体细胞 | LABORATORY of MASTITIS CONTROL 实验室细菌数控制 | DAIRY FARMS 牧场 Milk, Data, Events 产奶、数据和事件 |

VETERINARY DAIRY ASSOC. 奶牛兽医组织
Diagnosis, Treatments, Pathology 诊断、治疗和病理

DAIRY PLANTS 青草饲料 **Bulk Milk Information** 主要奶业信息

DHI HERD BOOK DATA BANK DHI牛群登记数据库

WEB NETWORK Web网络

BREEDING SYSTEM 育种系统

STATISTIC REPORTS 统计报告

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Slide 2

DHI HERDBOOK DATA BANK DHI牛群登记数据库

BREEDING SYSTEM 育种系统

STATISTIC REPORTS 统计报表

REPORTS on individual COWS 个体牛只报告

DATA and EVENTS out of NORMAL VALUES 异常数据和事件

REGULAR REPORTS on PRODUCTIVITY 生产常规报告

| HEALTH REPORTS 健康报告 | FERTILITY REPORTS 繁育报告 | GENETIC EVALUATIONS 遗传评定 |

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Slide 3

DHI-recording system summary in Israel – 1939 - 2009

Year 年份	Herds 牛群	Cows 牛只	Milk prod. (Kg)年单产 Cow/year	Fat prod. (Kg)乳脂 Cow/year	Fat% 乳脂率	Protein prod. (Kg)蛋白 Cow/year	Protein% 蛋白率	Fat and prot Prod. (Kg) Cow/year
1934	12	1,029	3,690	136	3.69			
1939	31	2,878	3,847	139	3.61			
1944	69	5,303	4,227	150	3.55			
1949	88	8,733	4,044	142	3.51			
1954	198	14,337	4,197	149	3.55			
1959	181	16,917	5,347	186	3.48			
1964	202	24,013	5,694	186	3.27			
1969	212	34,132	6,271	204	3.25			
1974	214	47,161	6,833	220	3.22			
1979	212	61,947	7,855	256	3.26			
1984	205	66,000	8,734	287	3.29			
1989	479	72,645	9,092	288	3.17	273	3.00	561
1994	802	92,175	9,748	302	3.10	289	2.96	591
1999	916	98,485	10,469	341	3.26	321	3.07	662
2004	775	99,537	10,668	381	3.57	331	3.10	712
2008	688	103,895	11,461	415	3.52	367	3.16	782
2009	680	83,556	11,945	419	3.51	374	3.13	786

Data from the "israeli herdbook report, 2009"   San Yuan 10 years seminar 2011

Slide 4

每头牛每年平均产量**1934-2008**（公斤**/**年）
ANNUAL AVERAGE PRODUCTION PER COW 1934 - 2008 (KG/YEAR)

产量 乳蛋白 乳脂率

Milk Fat Protein

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数据来《自以色列奶业年鉴-2008》Data from the "Israeli Herdbook Report- 2008"

Slide 5

Annual milk production, milk-fat and Milk-protein percent between 1995 - 2009
1995-2009年间年产量、乳脂及蛋白率

乳脂 Fat
Milk 牛奶
蛋白 Protein
MILK (Kg)

Data from the "Israeli Herdbook Report- 2009"   San Yuan 10 years seminar 2011

Slide 6

The effect of using DHI as managerial tool on milk production in San Yuan

San Yuan
Other big farms in China
Milk production kg/cow/year
Year

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What are the main principles of DHI record analysis
DHI记录分析的主要原则

Management of a dairy herd focuses around these five "**Key Management Areas**."
牛群管理关键在于以下五个"关键管理方面"

Key Management Areas
关键管理方面

Production产奶
Herd Lactation Status牛群胎次分布
Reproduction繁殖
Udder Health乳房健康
Culling & Replacements入群与淘汰

The performance of a herd in each of the management areas can be quickly assessed using five "Key Performance Indicators."
牛群在每个管理方面的生产性能可以使用五个"生产关键要素"快速评定

Key Performance Indicators
关键生产要素

Milk per cow per day 日单产
Days in milk 泌乳天数
Pregnancy rate 妊娠率
Somatic cell count 体细胞数
Culling rate 淘汰率

将关键管理方面（KMA）与关键生产要素（KPI）
KMA ⟶ KPI

Production——Milk/Cow/Day
产奶——日产量
Herd Lactation Status——Days in Milk（DIM）
牛群胎次分布——泌乳天数
Reproduction——Pregnancy rate
繁殖——妊娠率
Udder Health——Somatic cell count
乳房健康——体细胞数
Culling & Replacement——Culling rate
死淘——淘汰率

The analyzing principle
分析原则
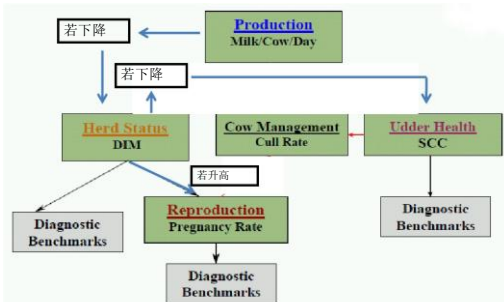
What is needed for DHI analysis

1. **DHI files of San Yuan DHI center**
1. 三元**DHI**中心的**DHI**文件
2. **AFIFARM reports of the farm**
2. 阿菲金系统牧场报告
3. **JMP or SAS statistical package**
3. **JMP or SAS** 统计程序包

2011/7/19

First step 第一步

Milk production, Lactation curve and stage of lactation
奶产量、泌乳曲线和泌乳期

DHI center
DHI中心

DHI file
DHI 文件

AfiFarm

Yearly dbase file
年度数据文件

Monthly DHI data
DHI月报数据

JMP
analysis
JMP分析

DHI Report JMP分析

DHI Report
DHI报告

JMP
analysis
JMP分析

DHI Report
DHI 报告

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Parity 胎次

- Milk production increases with lactation number and is maximized in the fourth or the fifth lactation.
- 随着胎次的增加，产奶量逐胎上升，到第四和第五胎到达最高峰
- Therefore, the distribution of cows in parities could be an important factor that influences the average milk production of a herd.
- 因此，胎次同样也是一个影响牛群产量的重要因素

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Cows number distribution
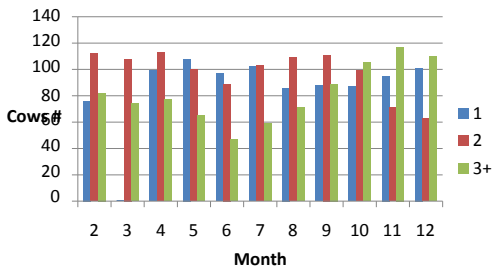
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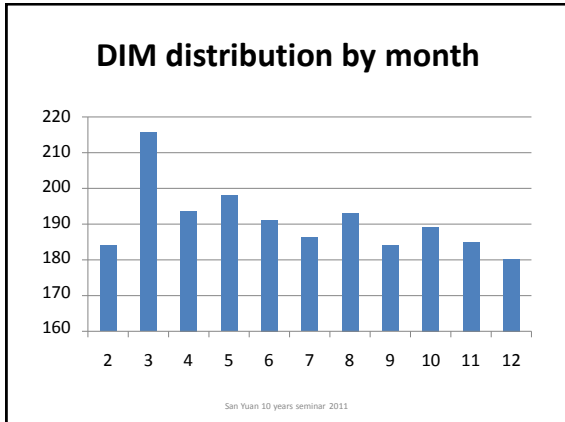**Simple average of monthly milk production**
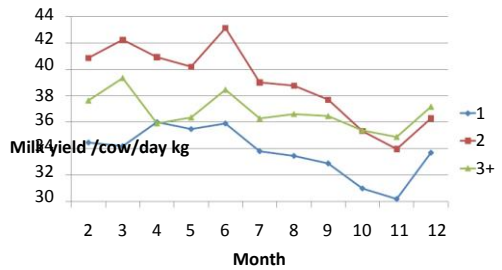
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Reduced data variation by parity is not enough !

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Milk production vs. DIM
产量和泌乳天数的线性相关性

$y = -0.0764x + 47.665$
$R^2 = 0.8368$

Milk production kg/day

DIM泌乳天数

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DIM distribution by month
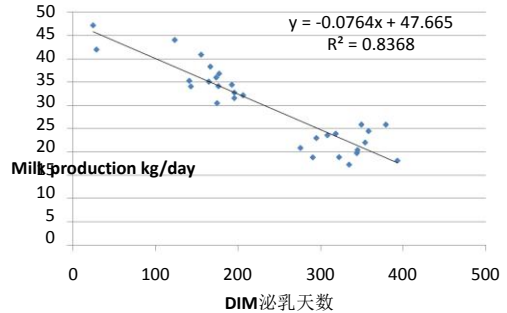
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**We have to reduce variation by selecting narrow range of DIM**

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Peak milk 高峰奶

- **Peak milk** is the highest daily milk production achieved by each cow in the herd during their current lactation.
- 高峰奶 是指每头牛当前胎次每头牛的高峰期产奶量
- Highest value (Kg of milk) in the 6 milk tests (1-6) that are considered.
- 前6次测定日中最高产奶量
- **Peak days** The ordinal days of Lactation in which the Peak of Lactation took place.
- 高峰期 高峰产奶出现日
- Ideally, a cow will peak around 60-100* DIM and remain at that level through the next test.
- 理想来说，高峰日出现在泌乳期的60-100天并且持续到下一个测定日

* (1st lactation cows 80-100 d and 2nd +adult 60-80 d)

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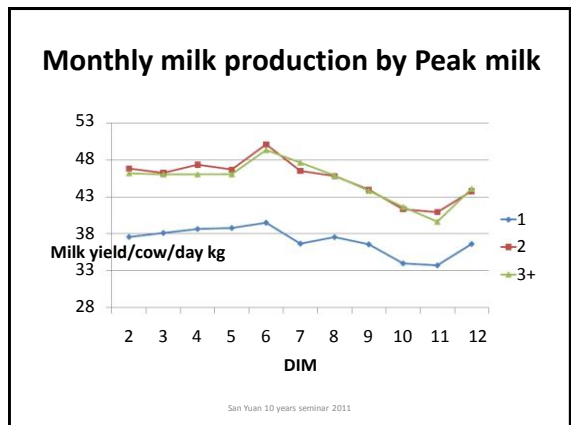
Stage of lactation胎次分布

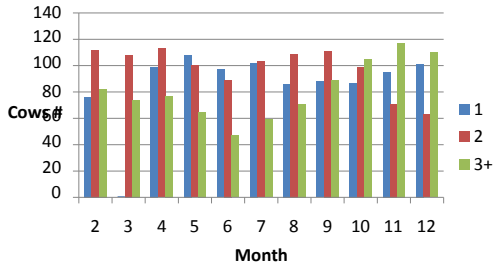San Yuan 10 years seminar 2011
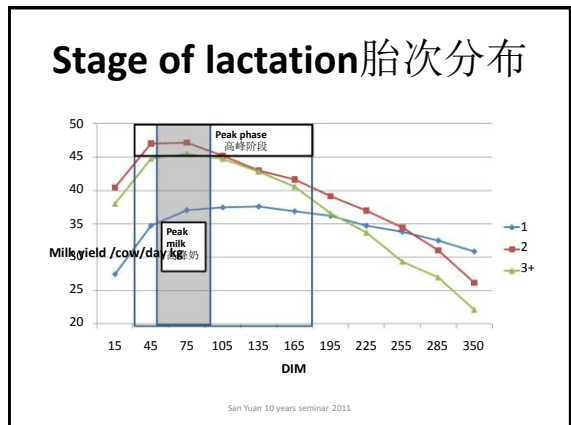
Peak milk 高峰奶

- Milk peaks directly impact dairy farm profitability.
- 高峰奶直接影响牧场收益
- Each increase of one kg in peak milk production equals an additional 110-140 kg of milk per cow per lactation.
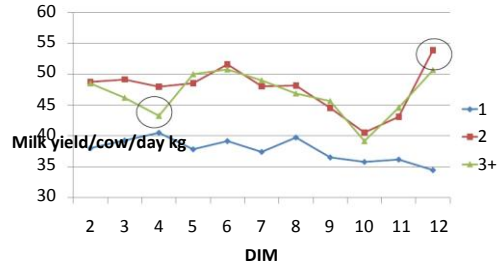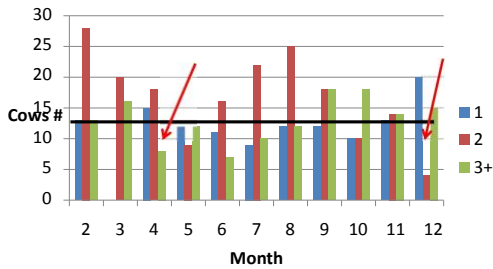- 高峰日产奶增加1kg，整个泌乳期产奶量增加110-140kg

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Monthly milk production by Peak milk

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Cows number distribution

Monthly peak milk production
月平均高峰日产奶

Cows # distribution
牛群胎次分布

Benchmark

- The dictionary defines a benchmark as:
- A "point of reference."
- It can be related to a:
    - Goal
    - Beginning point
    - Minimum or maximum acceptable level.
- Benchmarks are goals set for profitable herds and are generally based on performance by the "Top Performers" in the industry (company).
- These can be indicators of the degree of your success or failure.

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Peak of lactation
胎次高峰

	Bench mark Kg	% lactation	# of cows	% lactation	Actual kg
PEAK OF LACTATION (Kg)					
1st. Lactation	38.5	75-80	277	76.8	38.14
2nd. Lactation	48.0	92-95	249	103	49.61
3rd. Lactation + (ADULT)	50.6	100	263	100	47.94
TIME OF PEAK OF LACTATION (months)					
1st. Lactation	3.3		277		3.26
2nd. Lactation	2.3		249		2.31
3rd. Lactation + (ADULT)	2.3		263		2.07

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Total lactation milk is affected not only by peak milk but also by the persistency

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Persistency 持续力

- Persistency is a measure of how well animals are maintaining production.
- 持续力衡量牛群生产维持能力
- Production normally decreases 7 to 8% per month after peak milk is achieved.
- 到达产奶高峰后，产奶量每月降幅是7%到8%
- Larger decreases are referred to as poor persistency.
- 降幅大了持续力差

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- Production should increase from the first test to the second test, remain fairly constant from the second test to the third test.
- 产奶量从首测日到第二个测奶日会有增长，第二个测奶日到第三个测奶日保持恒定
- After the third test, cows should average 92 to 93% of the previous month's production per month throughout the lactation.
- 泌乳期内，从第三个测奶日往后，每月测奶产量是上个测奶日得92%到93%
- Heifers will average 94 to 96% of the previous months production from following the third test through the lactation.
- 头胎牛是上月的94%到96%
- Heifers - 94-96% of previous production after the third test
- 2nd Lactation & Mature Cows - 92-93% of previous production after the third test

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Stage of lactation
胎次分布

DIM	45	75	105	135	165	195	225	255	285	>350
1	20	31	38	35	38	36	35	38	33	28
2	26	44	51	43	43	38	40	38	31	25
3+	32	41	51	49	41	36	36	38	30	19
	start		peak		peak					Avg.
1	Diff.	10.7	6.73	-2.81	3.58	-1.84	-1.28	2.3	-4.52	-4.67	-1.32
2	Diff.	17.8	7.02	-7.83	0.02	-4.85	1.36	-1.33	-7.23	-5.6	-3.64
3+	Diff.	8.26	10	-2.04	-7.09	-5.77	0.78	1.76	-7.7	-11	-4.44
			Persistency							Avg.
1					0.95	0.97	1.09	0.87	0.85	0.94
2			0.84	1.00	0.88	1.05	0.95	0.82	0.81	0.91
3+			0.96	0.84	0.88	1.00	1.06	0.79	0.63	0.88

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The effect of DIM distribution on milk production
泌乳天数对产奶量的影响
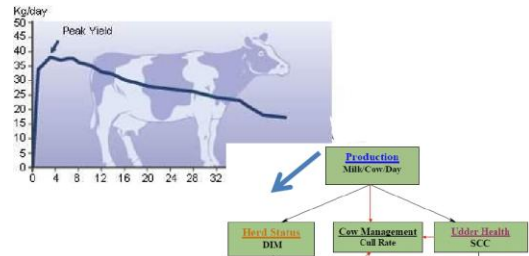
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300 days threshold

Production Cows # DIM <300	Production Cows # DIM >300

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Distribution of cows less than 300 DIM in 3 farms
3个牧场的牛群产奶分布
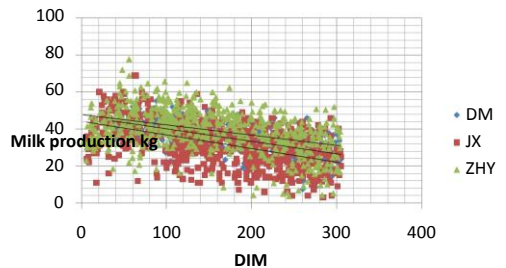
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The upper and the lower tenths of milk production in the 3 farms
最高和最低的**10**头平均产奶量

	JX	ZHY	DM
Less than 300 days (DIM) 300天泌乳日以下	HTM kg		
Upper tenth	46	53	46
Lower tenth	19	25.2	23.6
More than 300 days (DIM) 300天泌乳日以上			
Upper tenth	31	40	36.2
Lower tenth	12	17.5	15.6

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Distribution of DIM with threshold of 300 DIM
以泌乳天数**300**天为界的牛只比例

	JX	ZHY	DM
Less than 300 DIM	%		
1st lactation	65.3	70	64
2nd lactation	76.9	88	82
3rd+ lactation	81.9	88	87
More than 300 DIM			
1st lactation	34.7	30	36
2nd lactation	23.1	12	17
3rd+ lactation	18.1	12	13

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Distribution of DIM with threshold of 300 DIM
以泌乳天数**300**天为界的牛只比例

	JX	ZHY	DM
	Milk yield kg/cow/day 产奶量		
The situation now 全群	30	37.6	33.6
Only cows with less than 300 DIM 泌乳天数300天牛只	33	39.5	35.6
Difference差异	3	1.9	2

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If DIM was the reason for the change in milk production, we have now to check why DIM was changed !!

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Reproduction 繁殖

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繁殖Reproduction Chart

泌乳阶段12个月Lactation stages (12 months)

繁殖＝配准天数＝首配天数+发情鉴定率+怀孕率

Fertility = open days = rest period + heat detection efficancy + pregnancy rate

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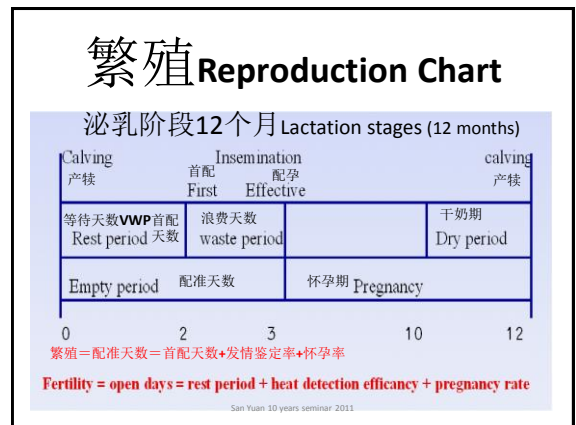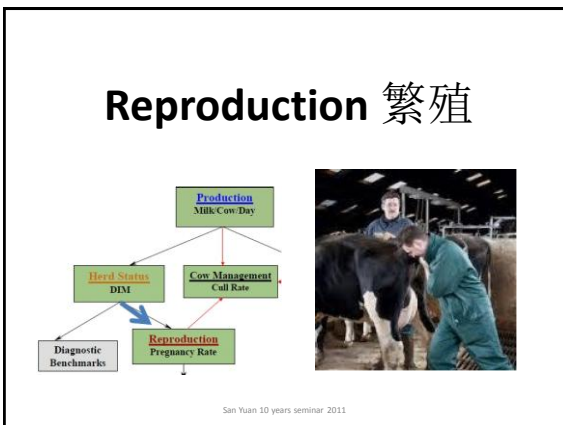
Reproduction (Terms)繁殖

- For an adequate evaluation of dairy cows fertility, we need to refer to certain standards.
- 为了充分评估牛群繁殖，我们需要依据特定的标准
- Cow fertility is generally evaluated by the 指标如下：
- **Average Days to 1st Service:** DIM from calving to first service attempt. This is calculated by summing the days to first service for all cows which have been bred at least once. The sum is divided by the number of those cows.
- 头胎牛泌乳天数
- **Wasted days:** The time between DFS to DES.
- 浪费天数：配种日期和配准日期间的时间段
- **Days open:** (the interval between calving and successful AI)
- 配准天数：产犊到成功配种的天数

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Reproduction (Terms)繁殖

- **Breeding interval :** Intervals between Heats and Services is a summary of the distribution of all intervals (in days) between reported heats and services for cows currently in the herd.
- ： 发情和配种
- **Calving interval :**(the interval between successive calving).
- 产犊间隔：两次产犊之间的时间段
- **Conception rate (CR):** The percent of services with known outcomes over a specified period of time that result in a pregnancy, or, alternatively, the number pregnant divided by number inseminated (and subsequently determined to be pregnant or not pregnant) over some time period.
- **Pregnancy rate (PR):** The percentage of eligible cows that becomes pregnant within a given time frame - usually 21 days.
- 妊娠率

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发情周期天数分布 Cycle length distribution

- 复配**Double inseminations:** 1－4天（发情时间长，发情初期开始配）1-4 days (long heats, inseminations on the early signs of the heat)
1. 短周期**Short cycles:** 5－17天（上次或当前配种时发情异常，卵泡囊肿）5-17 days (last or current insemination not on actual heat, cystic cows)
2. 正常周期**Normal cycles:** 18－24天 18-24 days (the usually assumed normal cycle length)
3. 长周期**Long cycles:** 25－36天（上次或当前配种时发情异常，胚胎死亡）25-36 days (last or current insemination not on actual heat, embryonic death)
4. 双周期**Double cycles:** 36－48天（遗漏了一个发情，或上次发情为安静发情）36-48 days (missed heats, "quiet" last heat)
- 超长周期**Very long cycles:** 大于48天（遗漏了发情，怀孕异常）more than 48 days (usually missed heats, abnormal pregnancies)

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AFIFARM Fertility table
金星牧场"阿菲金"繁殖报表

Heat Detection 发情鉴定	Heifers	1st lact.	2+ lact.	All cows	Total
Distribution of cycles	%	%	%	%	%
5-17 days	--	7.14	3.33	4.55	3.51
18-25 days	76.92	35.71	30.00	31.82	42.11
26-35 days	7.69	7.14	16.67	13.64	12.28
36-60 days	15.38	50.00	50.00	50.00	42.11
Breeding interval产犊间隔	26.00	35.00	35.00	35.00	33.00
Heat Detection accuracy 发情鉴定准确率	80.00	60.00	60.00	60.00	64.00
Conception rate 受胎率	55.80	38.50	43.60	41.05	45.97
Pregnancy rate 妊娠率	44.64	23.10	26.16	24.63	29.42

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Breeding Intervals
发情周期分布情况
Cycle length distribution
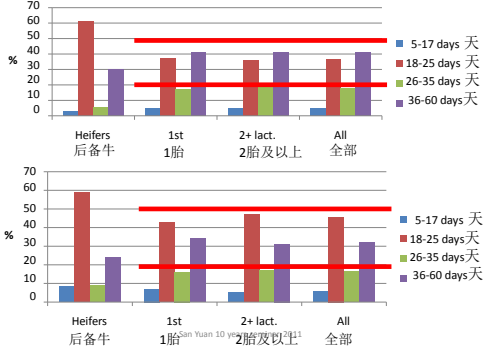
发情周期分布 以色列2009年
Heat detection statistic
Israeli Herd-book 2009

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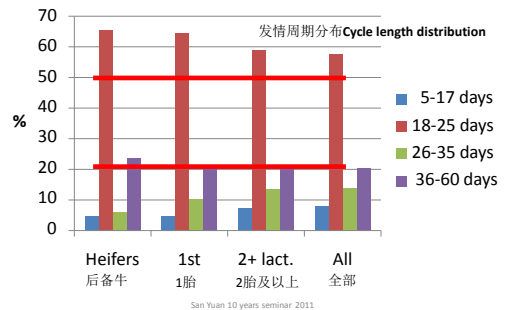
Table 6 - Reproductive performance of cows in JX farm (based on AfiFarm)

	Heifers	1st lactation	2+ lactation	All cows
Avg. days open	17.31	178	147	157
Avg. days to first service	15.74	79	74	76
Avg. Wasted Days	43	99	73	82
Open more then 150 DIM		36.8%	31.3%	33.1%
Avg. inseminations per cow	1.75	2.18	2.01	2.07
Avg. inseminations per pregnancy	1.85	2.47	2.32	2.37

Table 7 - Reproductive performance of cows in ZHY farm (based on AfiFarm)

	Heifers	1st lactation	2+ lactation	All cows
Avg. days open	15.48	127	126	126
Avg. days to first service	14.59	103	91	94
Avg. Wasted Days	25	30	43	39
Open more then 150 DIM		10.9%	15.1%	13.8%
Avg. inseminations per cow	1.25	1.19	1.3	1.27
Avg. inseminations per pregnancy	1.6	1.62	1.86	1.78

Table 8 - Reproductive performance of cows in DM farm (based on AfiFarm)

	Heifers	1st lactation	2+ lactation	All cows
Avg. days open	16	158	140	147
Avg. days to first service	15.38	57	59	58
Avg. Wasted Days	11	86	68	75
Open more then 150 DIM		25.0%	12.9%	15.4%
Avg. inseminations per cow	1.05	1.11	1.14	1.13
Avg. inseminations per pregnancy	1.42	2.2	2.19	2.19

Three farms comparison of the same production parameters

|	JX	DM	ZHY
Age at first calving (months) 初产月龄	28	27	25.5
Calving interval (days) 产犊间隔	436	419	409
Milking days 泌乳天数	370	350	339
Full lactation milk production kg 胎次产奶	11,100	11,760	12,746

Why heat detection is so important ?
为什么发情鉴定如此重要
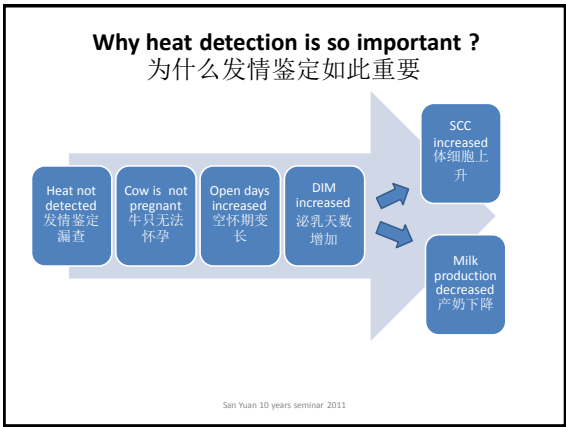
If reproduction is not the reason for reduced milk production, than we have to look for other reasons

udder problems is the most probable one

Somatic Cell Count
SCC体细胞数
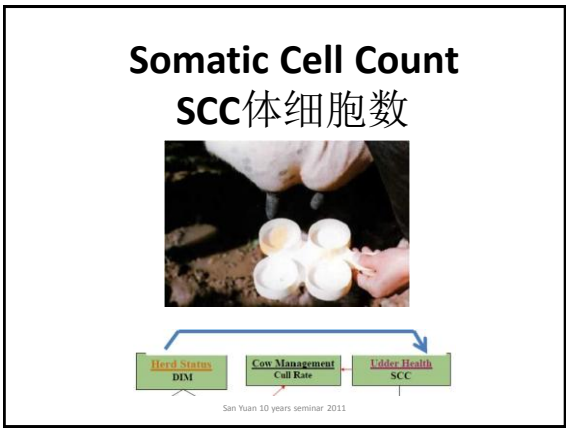
Mastitis and Somatic cell count
乳房炎和SCC

- The main disease that affect milk yield of dairy cows is mastitis.
- 乳房炎是影响牛只产奶量的主要疾病
- A high SCC is an indication of chronic, subclinical mastitis in the herd and is also an indication of significant economic losses.
- 高体细胞数是临床、隐性乳房炎的指标之一，也是经济损失的指标
- Mastitis is the most important factor affecting the SCC of an individual cow.
- 对于奶牛个体来说，乳房炎是影响SCC的最重要因素
- General agreement values: less than 100,000 cells/ml for uninfected cows and greater than 300,000 for cows infected with significant pathogens.
- 一般认为：少于每ml奶中体细胞含量少于100000的牛只没有感染，而大于300000的牛只感染了大量的病原菌
- Therefore, analysis of SCC level and distribution can give us a picture of how much milk is being lost due to the level and the distribution of SCC.
- 因此，分析SCC水平和分布让我们直观的看到不同的体细胞水平的奶损失

The effect of DIM on SCC in 3 farms
### 泌乳天数对于**SCC**的影响
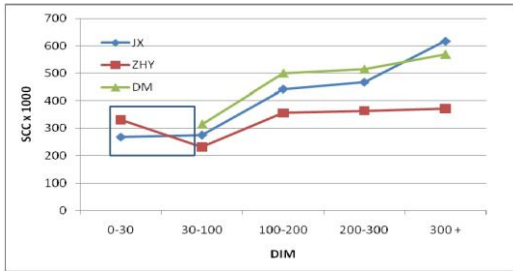
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SCC and new infections
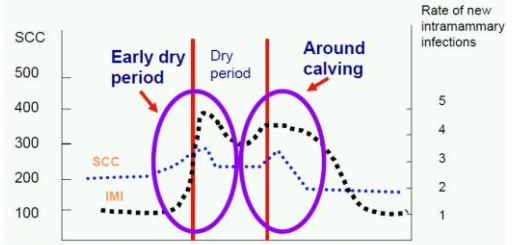
New intramammary infections significantly higher in the dry period than during lactation: **early dry period** and **around calving**
Rates of new intramammary infection in the dry period vary widely
The average rate of new infections in untreated dry cows is expected to be between 8 and 12% of quarters

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Mastitis in a dairy herd
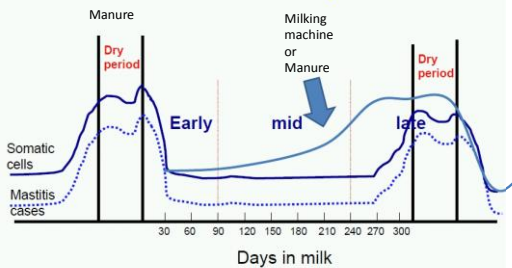
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Linear scores

- Linear scores (also termed Somatic Cell Count Score- SCCS) are determined by a mathematical expression standardizing a linear score unit to somatic cell count.
- Linear scores range from 0 to 9 and each unit increase reflects a doubling of somatic cell count midpoint.

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The SCCS and associated SCC

LS or SCCS	SCC Range			Midpoint
0	0	-	17,000	12,5000
1	18,000	-	34,000	25,000
2	35,000	-	70,000	50,000
3	71,000	-	140,000	100,000
4	141,000	-	282,000	200,000
5	282,000	-	565,000	400,000
6	566,000	-	1,130,000	800,000
7	1,131,000	-	2,262,000	1,600,000
8	2,263,000	-	4,525,000	3,200,000
9	4,526,000 San Yuan 10 years seminar 2011		9,999,000	6,400,000

Milk loss

- Assuming cows with linear scores of 4 or less are uninfected, potential milk loss for increasing linear scores can be determined.
- For every increase in 1 linear score unit above 2, 0.65 kg milk per day or 200 kg milk per lactation are lost for mature cows.
- Losses for first-lactation cows are one-half of those for mature cows.
- For a 100 cow dairy (assuming 50% heifers) with a herd linear score average of 4.0, this equates to 30,000 kg of lost milk in a year.
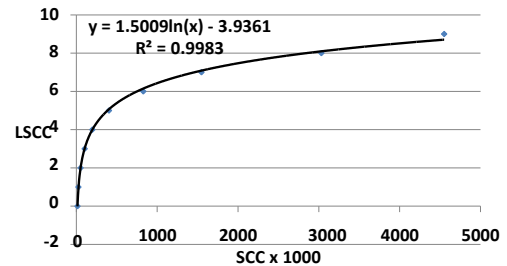
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Linear score calculation

- If, for instance, the SCC is 200 then:
- **1. Divide reported SCC (in 1000/ml) by 100**
  Example: SCC = 200 then 200/100 = 2
- **2. Determine the natural log (ln) of the number in step 1**
  Example: ln (2) =.693147
- **3. Divide the number in step 2 by 0.693147**
  Example: 0.693147 divided by 0.693147 = 1
- **4. Add 3 to the number in step 3**
  Example: 1 + 3 = 4
- The Linear Score for 200,000 SCC is 4.

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Linear score calculation

$y = 1.5009\ln(x) - 3.9361$
$R^2 = 0.9983$

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How are somatic cell data interpreted?

- **New infections**
- **Cured Infections**
- **Chronic Infections**
- **No infections**

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How are somatic cell data interpreted?

New Infections

- Defined as those cows that have a somatic cell count score (linear score) of 4 or greater on current test date and had a SCCS less than 4 on the previous test date.

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Cured Infections

- Defined as those cows that had a SCCS of 4 or greater on the previous test date, but have a SCCS less than 4 on the current test date.
- If this individual cow had been treated for mastitis between the two test dates, this might indicate a treatment success, or a spontaneous recovery.
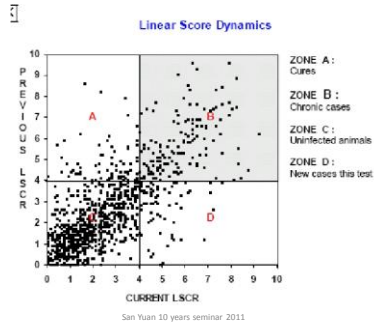
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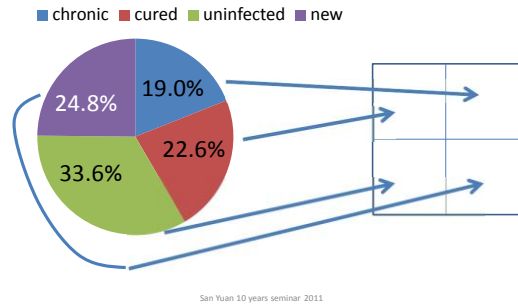
Chronic Infections

- Defined as those cows that have a SCCS of 4 or greater on 3 consecutive test dates.
- If this individual cow had been treated for mastitis at some point in time between these three test dates, this would indicate a treatment failure.

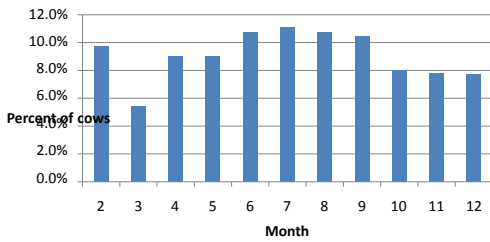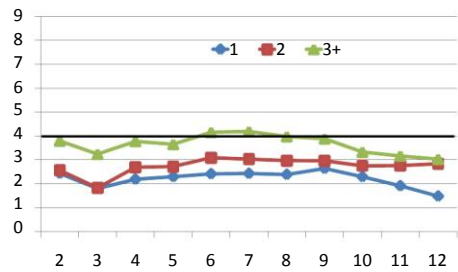San Yuan 10 years seminar 2011

Linear Score Dynamic

Linear Score Dynamic

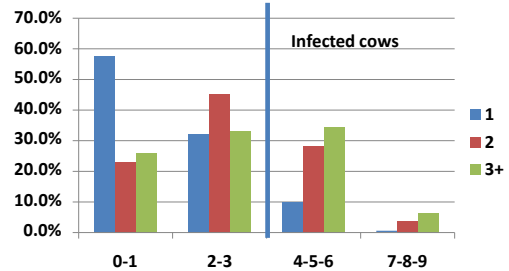## % SCC Linear >4

Average linear score by parity

Current SCC evaluation

Lact. #	Cows #	LSCC	% cows by Linear score				infected	Lscc <4
			0,1	2,3	4,5,6	7,8,9		
1	138	2.59	27.5%	48.6%	21.7%	2.2%	23.9%	76.1%
2	108	2.46	32.4%	41.7%	25.0%	0.9%	25.9%	74.1%
3+	170	3.12	23.5%	37.6%	33.5%	5.3%	38.8%	61.2%

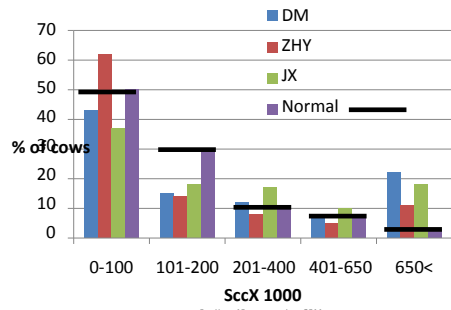San Yuan 10 years seminar 2011

LSCC

Distribution of herd by LSCC and month of test
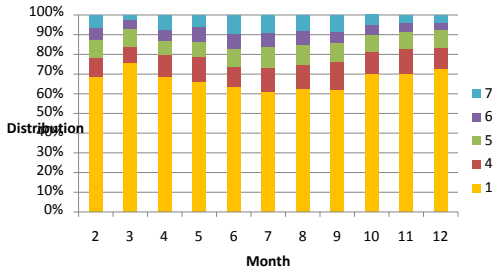
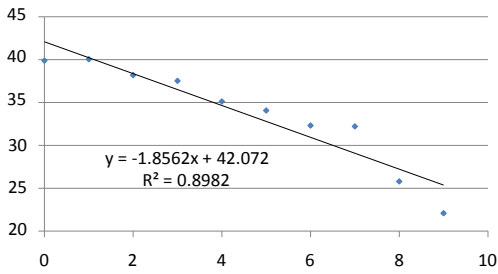

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The distribution of SCC in 3 farms in comparison to the target Israeli distribution
以以色列的牧场作为标杆，三家牧场的**SCC**分布

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The effect of level of infection on milk production in one of the farms

$y = -1.8562x + 42.072$
$R^2 = 0.8982$

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