Increasing milk production and feed efficiency

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- *Robert Schlaifer said; "When all the facts bearing on a business decision are accurately known-when the decision is made "under certainty"-careless thinking is the only reason why the decision should turn out, after the fact, to have been wrong. But when the relevant facts are not all known - when the decision is made "under uncertainty, it's impossible to make sure that every decision will turn out to have been right in this same sense. Under uncertainty, the businessman is forced, in effect, to gamble. Under such circumstances, a right decision consists in the choice of the best possible bet, whether it is won or lost after the fact"(Schlaifer, 1959).*

How do we help a dairy increase profit

- What is the goal of the dairy?
- Are the decisions based on profit or on specific outcomes such as decreased culling or improved feed efficiency or increased cow longevity?
- Are these the correct parameters to chase?
- How can we help make better decisions?
- There are multiple paths to profitability!
  - Every dairy that is still operating today, has an area they excel in. Other wise they would have went out of business
  - Good nutrition, forage production, cow health/care, labor organization, heifer rearing, finance,
  - Most have multiple areas.
- Can we help find the weak area?

So how do we impact profit?

How do we measure and set goals for the dairy enterprise?

- High milk production?
- Decrease feed per unit of milk?
- Cost / CWT?
- Net Revenue from the Profit Loss statement?
- Income minus Feed Cost?

What are the right items to measure and analyze so that we come up with the best decisions with the least amount of uncertainty?

Feed Efficiency

- Dr Hutjens (***Feed efficiency*** (FE) can be defined as Kg of fat-correct or energy-corrected milk produced per Kg of dry matter intake (DMI) consumed.

Table 2. Benchmarks for feed efficiency comparisons.

Group Milk/kg DM	Days in Milk	FE (kg milk/kg DM)
One group, all cows	150 to 225	1.4 to 1.6
1st lactation group	< 90	1.5 to 1.7
1st lactation group	> 200	1.2 to 1.4
2nd + lactation group	< 90	1.6 to 1.8
2nd + lactation group	> 200	1.3 to 1.5
Fresh cow group	< 21	1.3 to 1.6

28th Annual West Canadian Dairy Seminar 2010 Benchmarking Your Feed Efficiency, Feed Costs, and Income over Feed Cost.

What changes Feed Efficiency

- Physiological status of the cow
  - Age,
  - Stage of lactation,
  - Health,
  - Level of production,
  - Environmental conditions,
- Digestive Function
  - Feeding Behavior
  - Passage rate
  - Rumen fermentation,
  - Microbiome
- Metabolic partitioning
  - Homeorhesis,
  - Insulin sensitivity
  - Hormonal profile
- Genetics
- Nutrition
  - Ration formulation,
  - Nutrient balance

Bach, A. 2019 “Symposium review: Decomposing efficiency of milk production and maximizing profit.”, J. Dairy Science 103:5709-5725

Driver of Profit for the Dairy

- Milk production is the engine that drives revenue!
- While feed efficiency helps us understand how the cows are converting raw ingredients to the final product.
- We are really only concerned with how high is the stack of dollars left over after feeding the raw material into the milk engine.

Pivot of Dairy Herd Production

Pens	AVG ECM	Pen Count	Avg DSF	Avg Pen Ration Cost	Avg of IOFC	Avg of FeedEff	Avg of $/CWT
H	**87.6**	**2533**	**149**	**$ 10.49**	**$ 7.16**	**1.48**	**$ 13.98**
L	**64.6**	**1579**	**271**	**$ 7.82**	**$ 5.19**	**1.21**	**$ 15.44**
Total	**78.8**	**4112**	**196**	**$ 9.47**	**$ 6.40**	**1.38**	**$ 14.54**
1	76.3	153	82	$ 9.97	$ 5.40	1.38	$ 16.22
2	87.5	196	115	$ 10.78	$ 6.85	1.49	$ 14.76
5	89.4	349	211	$ 9.63	$ 8.37	1.40	$ 12.22
6	88.4	445	127	$ 10.33	$ 7.47	1.54	$ 13.66
7	84.6	483	144	$ 11.09	$ 5.95	1.38	$ 15.48
10	91.2	358	138	$ 11.30	$ 7.08	1.47	$ 14.33
22	94.8	154	167	$ 11.41	$ 7.70	1.52	$ 13.72
23	88.8	124	186	$ 10.14	$ 7.75	1.62	$ 12.79
28	81.4	147	203	$ 9.34	$ 7.05	1.59	$ 13.06
29	92.4	124	125	$ 9.56	$ 9.06	1.76	$ 11.77
3	51.8	228	295	$ 7.95	$ 2.49	0.95	$ 18.45
4	76.9	397	245	$ 8.22	$ 7.26	1.34	$ 12.21
8	62.5	282	282	$ 7.31	$ 5.28	1.24	$ 20.62
9	64.2	310	292	$ 7.84	$ 5.09	1.17	$ 14.06
24	63.8	146	233	$ 9.06	$ 3.79	1.23	$ 16.20
25	61.6	131	280	$ 6.75	$ 5.66	1.31	$ 12.37
26	56.3	85	274	$ 6.84	$ 4.50	1.18	$ 13.63

Cutting and slicing data

- How do we investigate?
- What are some tools we can use

- The problem with data is looking at the forest and not seeing the trees.
- Or seeing the variability of the entire data set and not realizing there are patterns within the population.

Pivot of Dairy Herd Production sorted on IOFC

- Feed Efficiency doesn't predict IOFC
- Avg $/CWT doesn't predict IOFC

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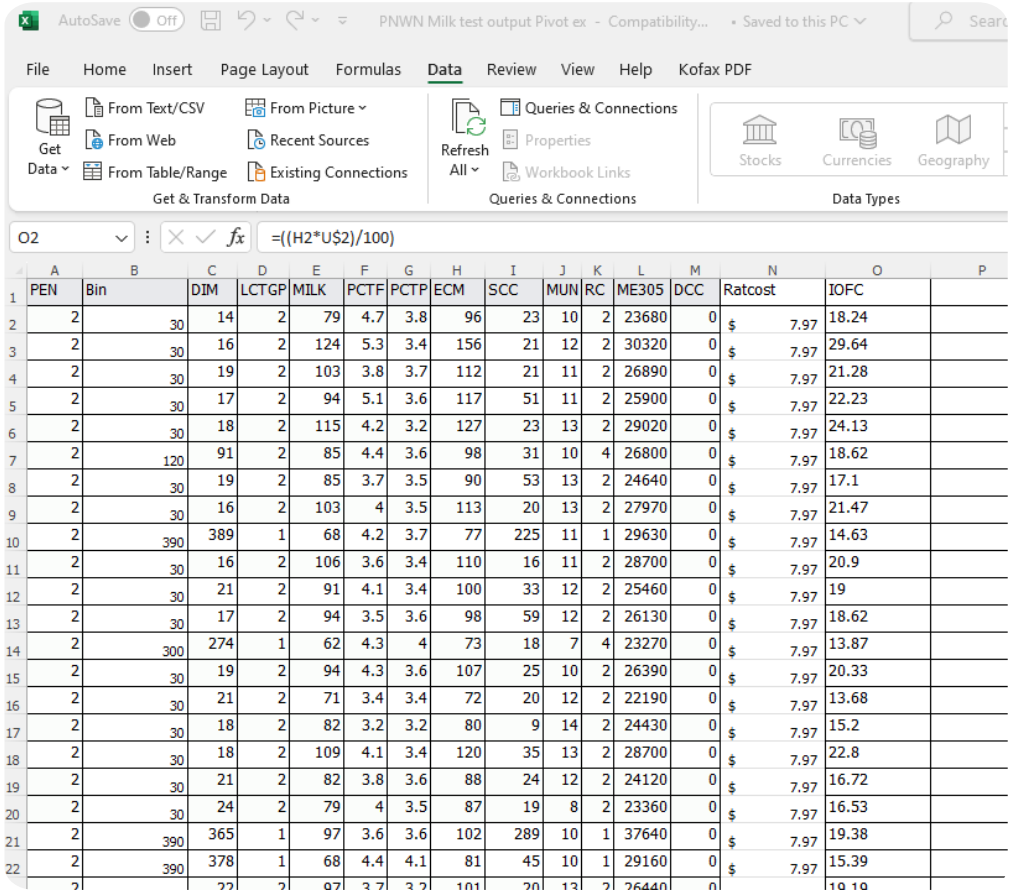
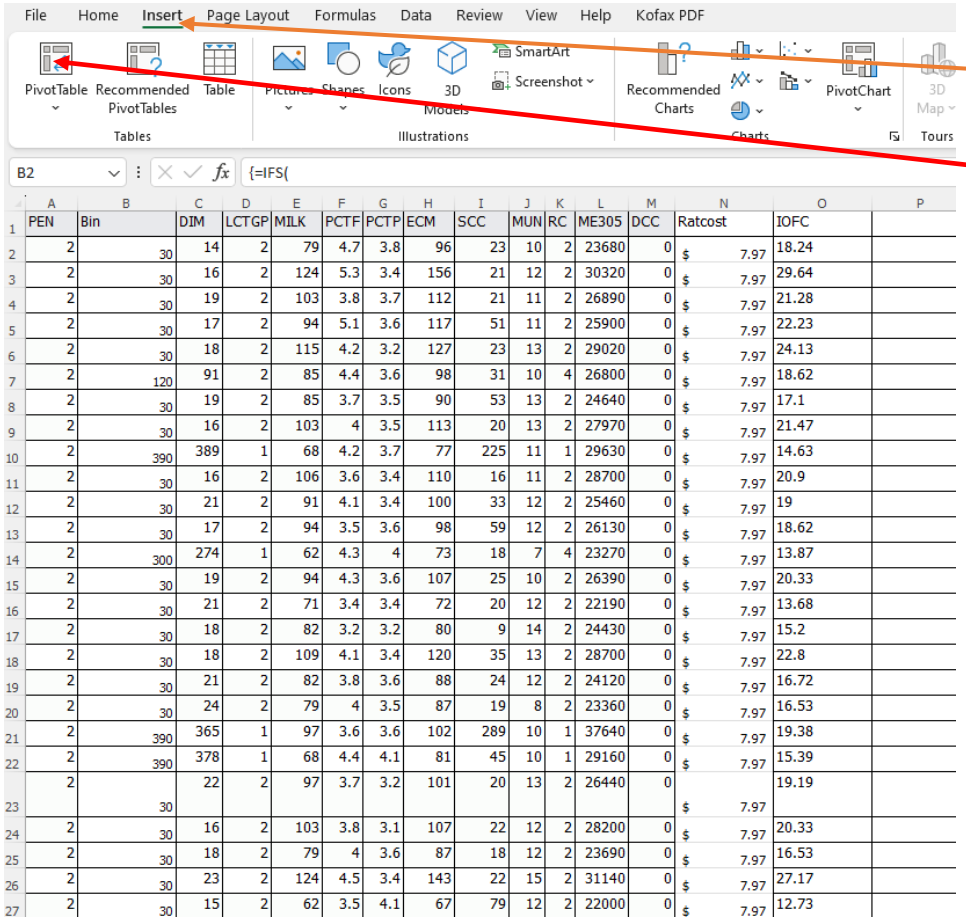


	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	PEN	Bin	DIM	LCTGP	MILK	PCTF	PCTP	ECM	SCC	MUN	RC	ME305	DCC	Ratcost	IOFC	
2	2	30	14	2	79	4.7	3.8	96	23	10	2	23680	0	$ 7.97	18.24	
3	2	30	16	2	124	5.3	3.4	156	21	12	2	30320	0	$ 7.97	29.64	
4	2	30	19	2	103	3.8	3.7	112	21	11	2	26890	0	$ 7.97	21.28	
5	2	30	17	2	94	5.1	3.6	117	51	11	2	25900	0	$ 7.97	22.23	
6	2	30	18	2	115	4.2	3.2	127	23	13	2	29020	0	$ 7.97	24.13	
7	2	120	91	2	85	4.4	3.6	98	31	10	4	26800	0	$ 7.97	18.62	
8	2	30	19	2	85	3.7	3.5	90	53	13	2	24640	0	$ 7.97	17.1	
9	2	30	16	2	103	4	3.5	113	20	13	2	27970	0	$ 7.97	21.47	
10	2	390	389	1	68	4.2	3.7	77	225	11	1	29630	0	$ 7.97	14.63	
11	2	30	16	2	106	3.6	3.4	110	16	11	2	28700	0	$ 7.97	20.9	
12	2	30	21	2	91	4.1	3.4	100	33	12	2	25460	0	$ 7.97	19	
13	2	30	17	2	94	3.5	3.6	98	59	12	2	26130	0	$ 7.97	18.62	
14	2	300	274	1	62	4.3	4	73	18	7	4	23270	0	$ 7.97	13.87	
15	2	30	19	2	94	4.3	3.6	107	25	10	2	26390	0	$ 7.97	20.33	
16	2	30	21	2	71	3.4	3.4	72	20	12	2	22190	0	$ 7.97	13.68	
17	2	30	18	2	82	3.2	3.2	80	9	14	2	24430	0	$ 7.97	15.2	
18	2	30	18	2	109	4.1	3.4	120	35	13	2	28700	0	$ 7.97	22.8	
19	2	30	21	2	82	3.8	3.6	88	24	12	2	24120	0	$ 7.97	16.72	
20	2	30	24	2	79	4	3.5	87	19	8	2	23360	0	$ 7.97	16.53	
21	2	390	365	1	97	3.6	3.6	102	289	10	1	37640	0	$ 7.97	19.38	
22	2	390	378	1	68	4.4	4.1	81	45	10	1	29160	0	$ 7.97	15.39	

Make a Pivot Table

- Output from DC305 to Excel
- I used “Show Pen DIM LCTGP Milk PCTF PCTP ECM SCC MUN RC ME305 DCC”
- Made a BIN Statement
- Added Ration Cost.
- Added IOFC

Make a Pivot Table



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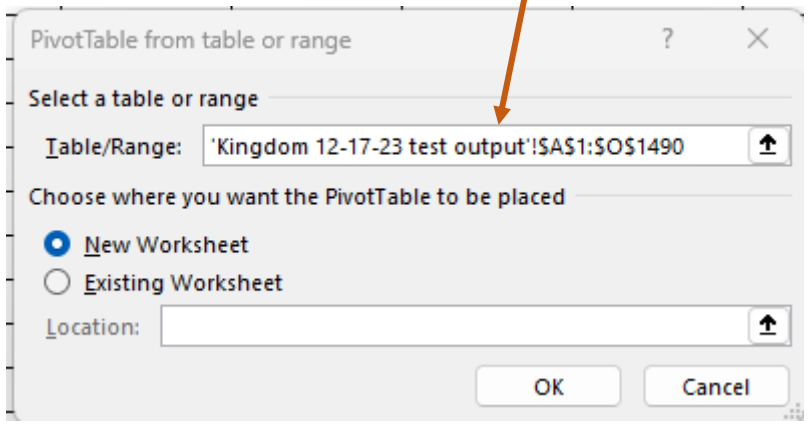
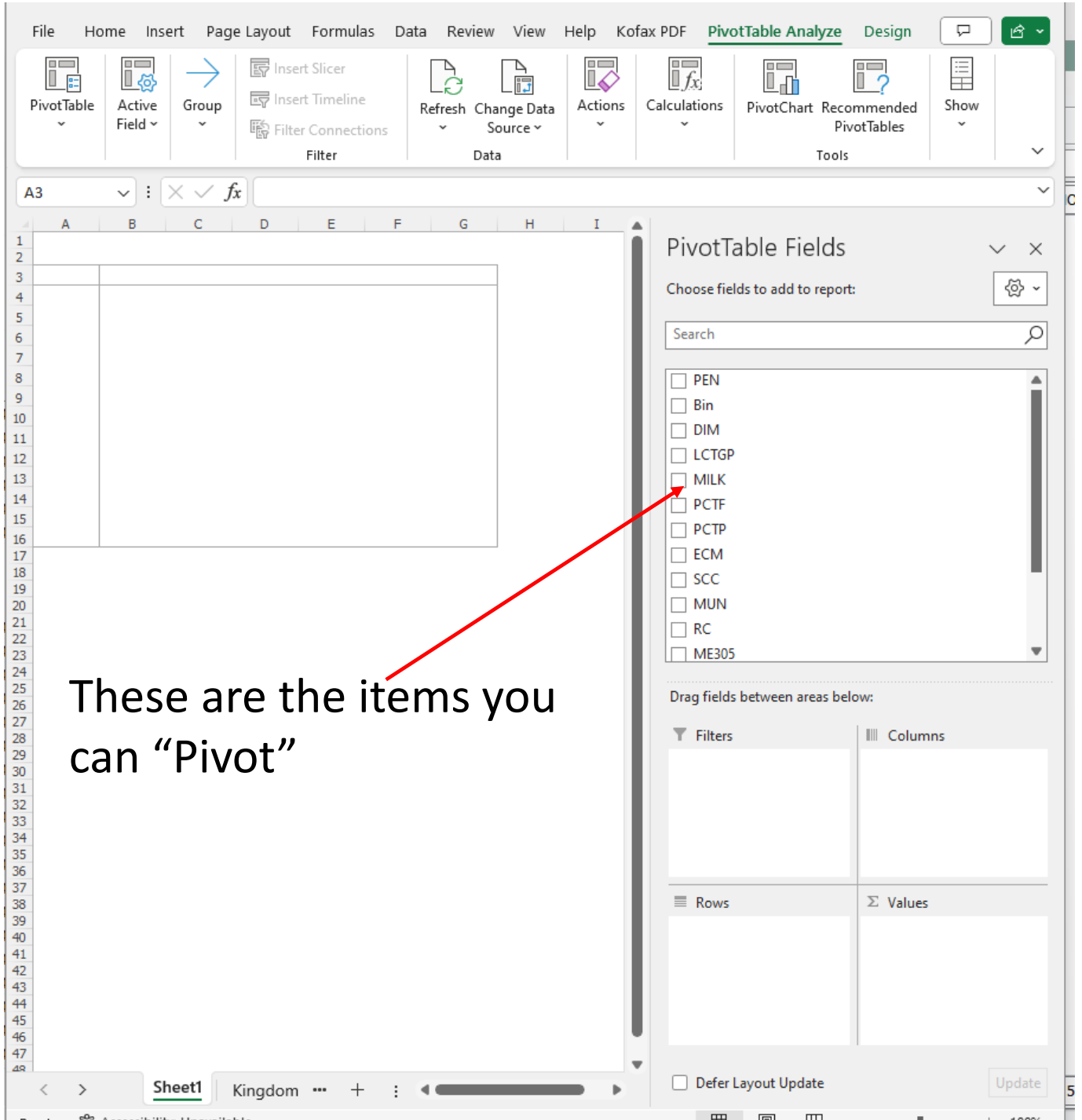
27	2	30	15	2	62	3.5	4.1	67	79	12	2	22000	0	$ 7.97	12.73	

- In Excel - Insert
- Then Pivot Table
- Put it in a New Worksheet, it will automatically choose the set of data you are working in. - OK



Get a Pivot Page

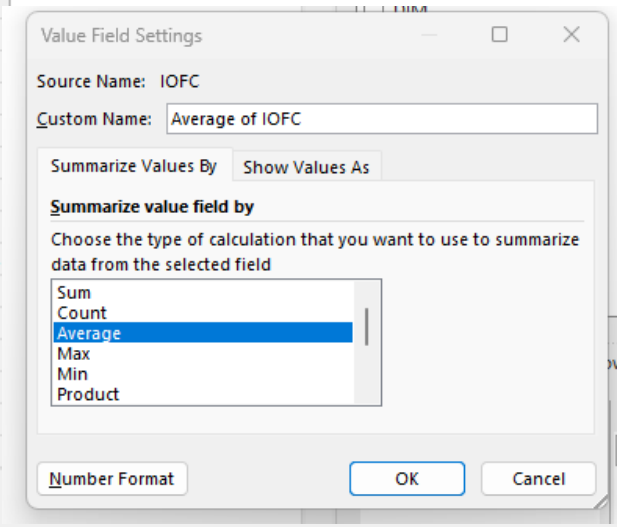


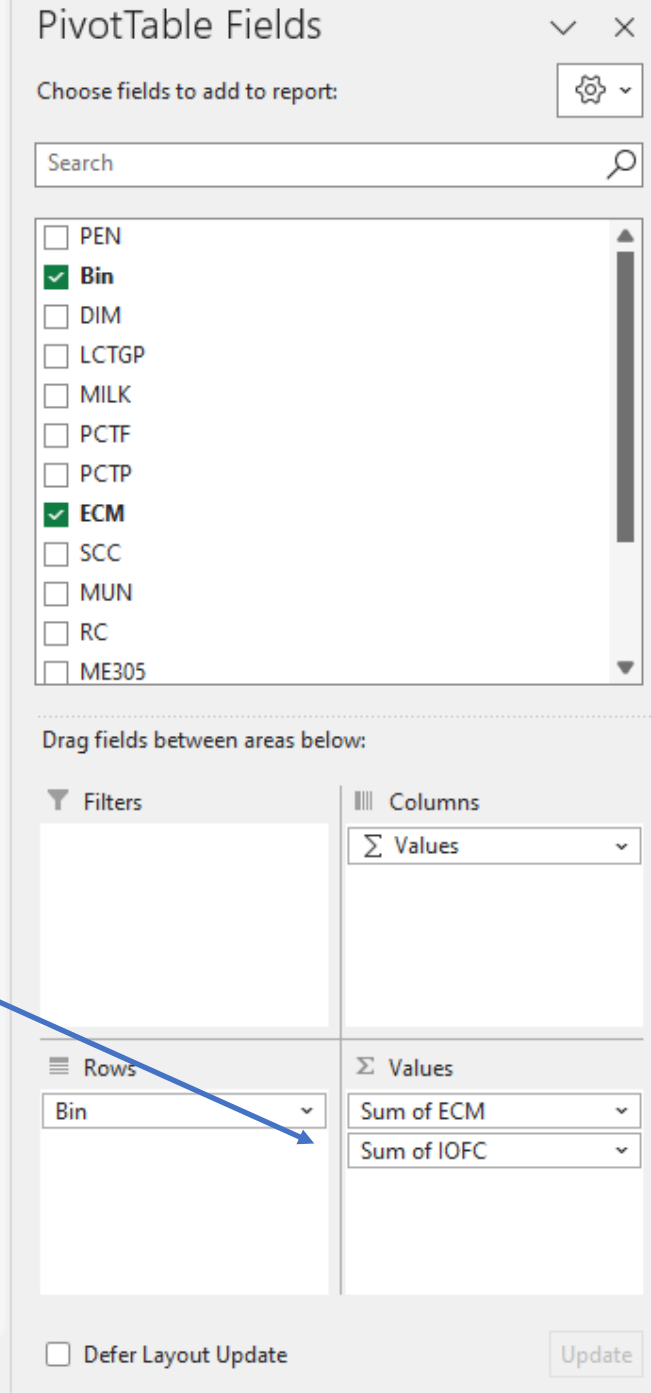
Pivot the Table

Pivoted Data By DIM BIN

	Data	
Bin	Sum of ECM	Sum of IOFC
30	14491	2753.29
60	11863	2253.97
90	12260	2329.4
120	13702	2603.38
150	17106	3250.14
180	14210	2699.9
210	10943	2079.17
240	11533	2191.27
270	8222	1562.18
300	4993	948.67
330	2820	535.8
360	2234	424.46
390	1795	341.05
#N/A	65	12.35
Grand Total	126237	23985

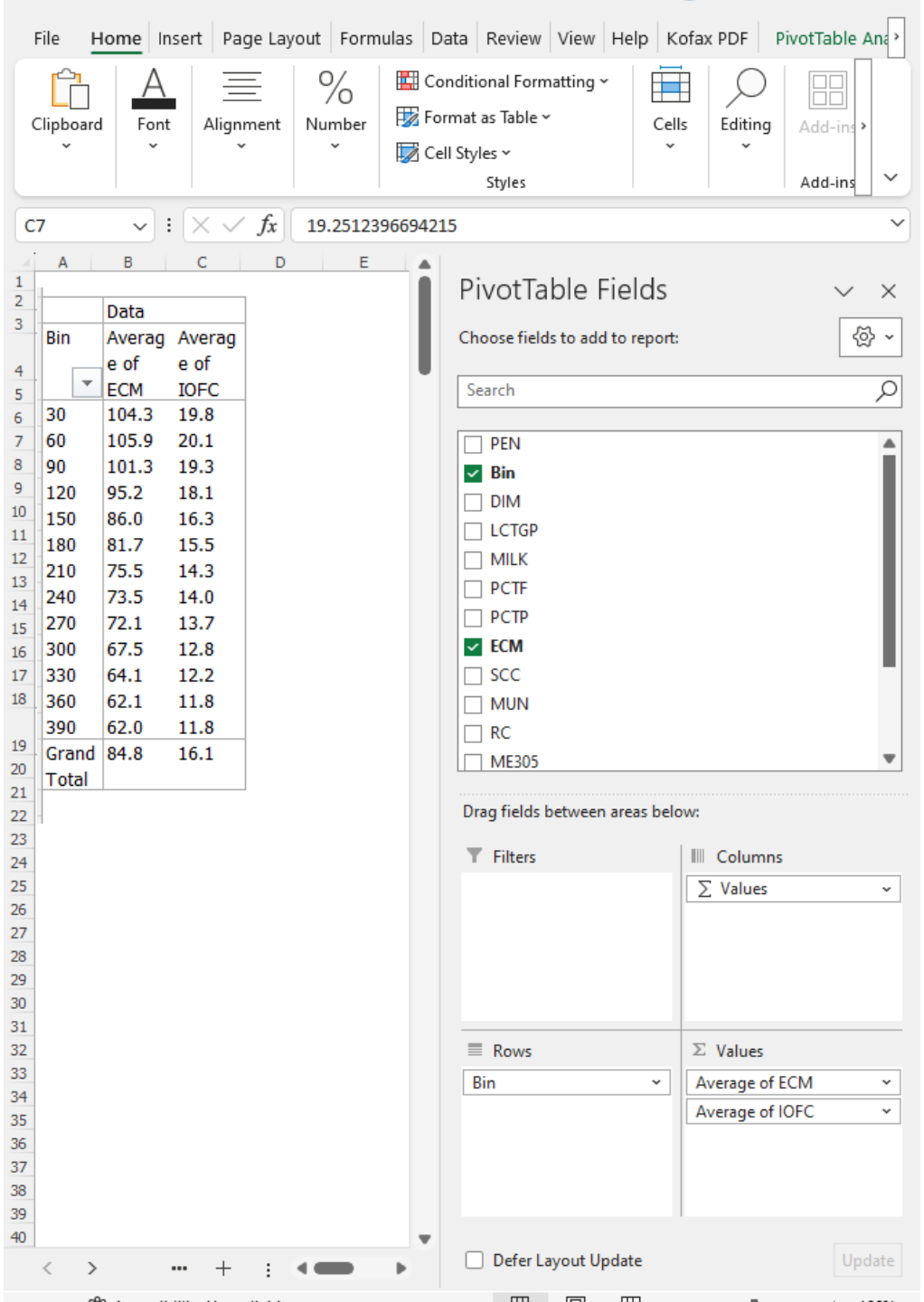
Need to convert to average instead of SUM





Final chart of ECM and IOFC by DIM group

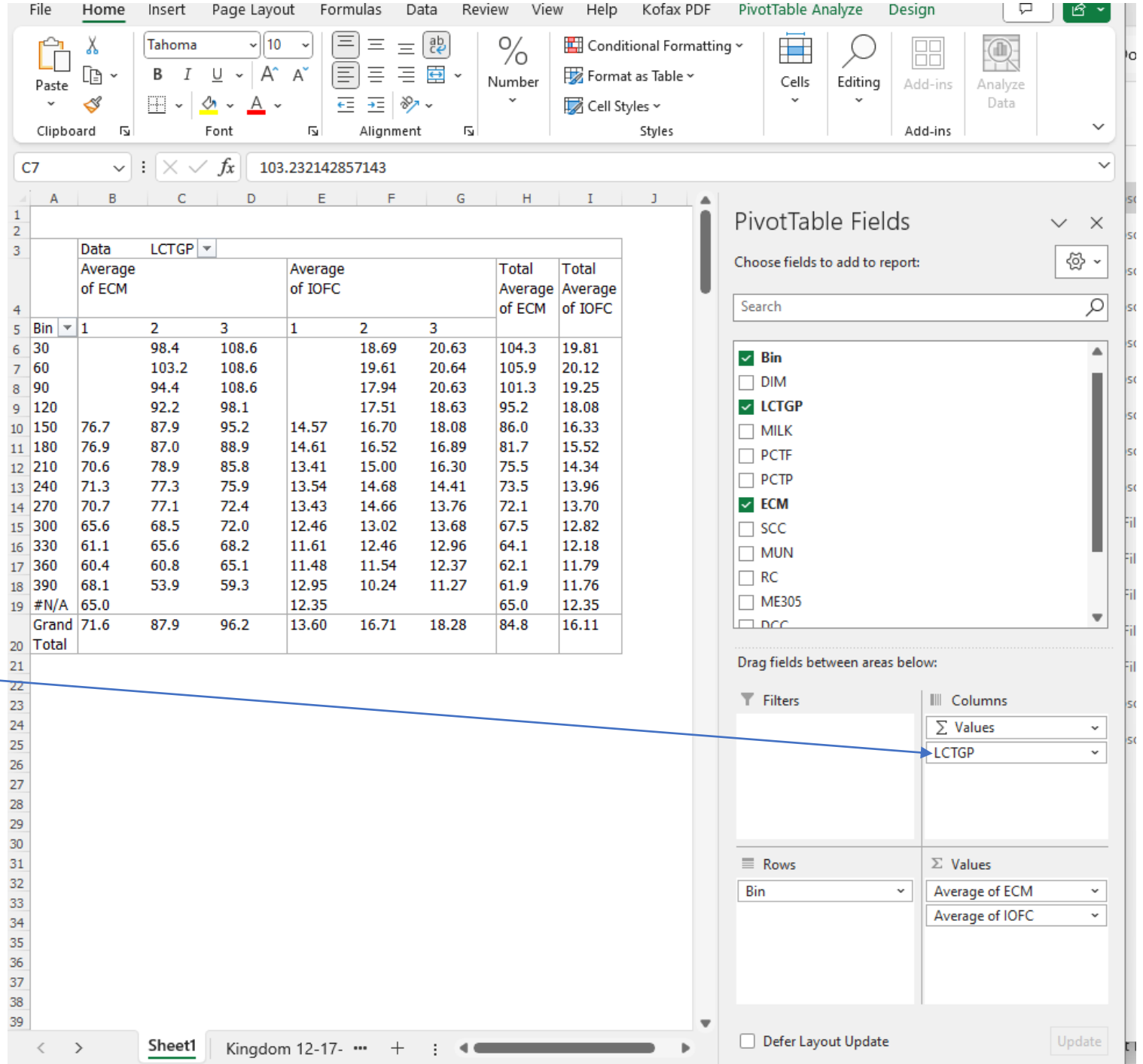
120



Add to the Pivot, Break it down by Lact Group

Adds columns with Lact Group, You can see this farm has no heifers less than 150 DIM

You can pivot any of the data simply by dragging a new item to the boxes such as you could look at MUN by pen or SCC by lactation.



Looking at individual data and variation

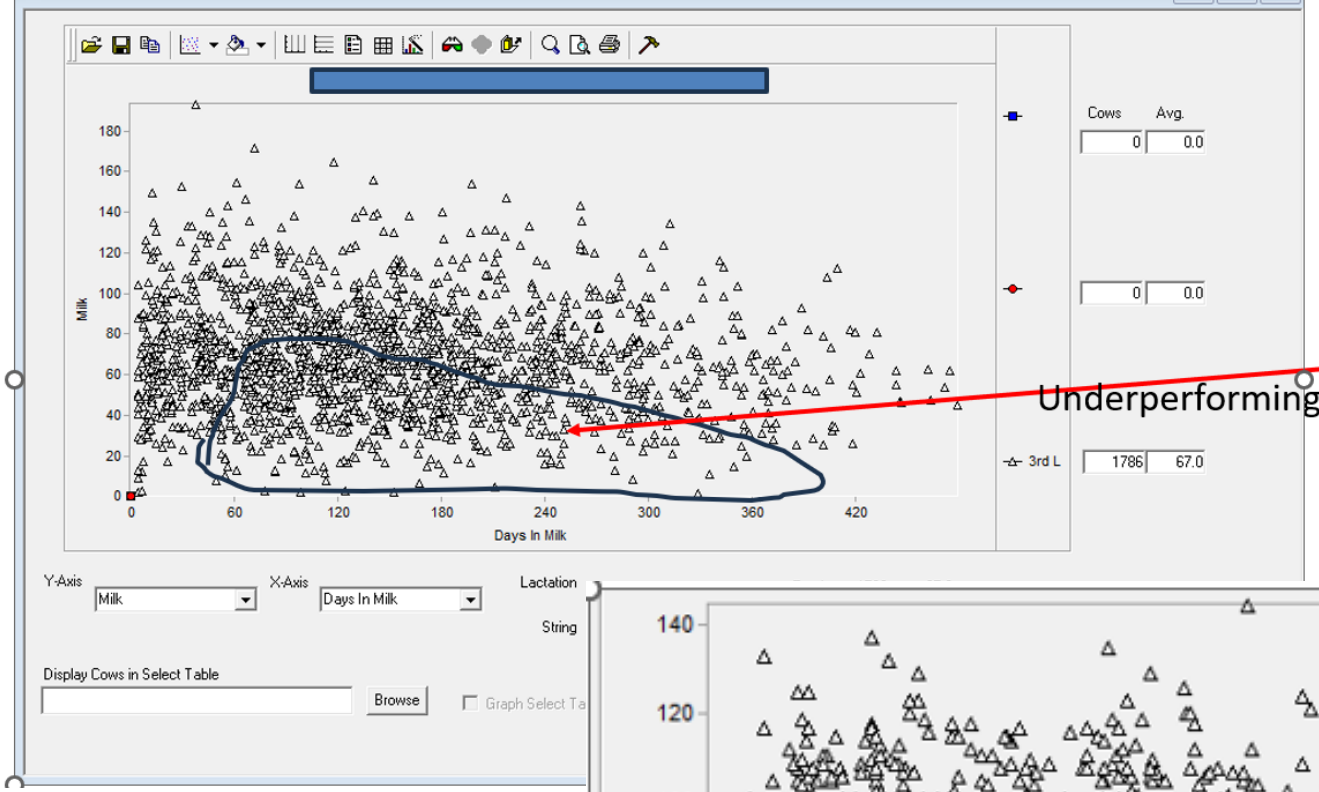
There is value in seeing where individual animals are performing.

Especially in relation to the change in DIM in the herd

Or by Pen to see if there are specific problems within PEN

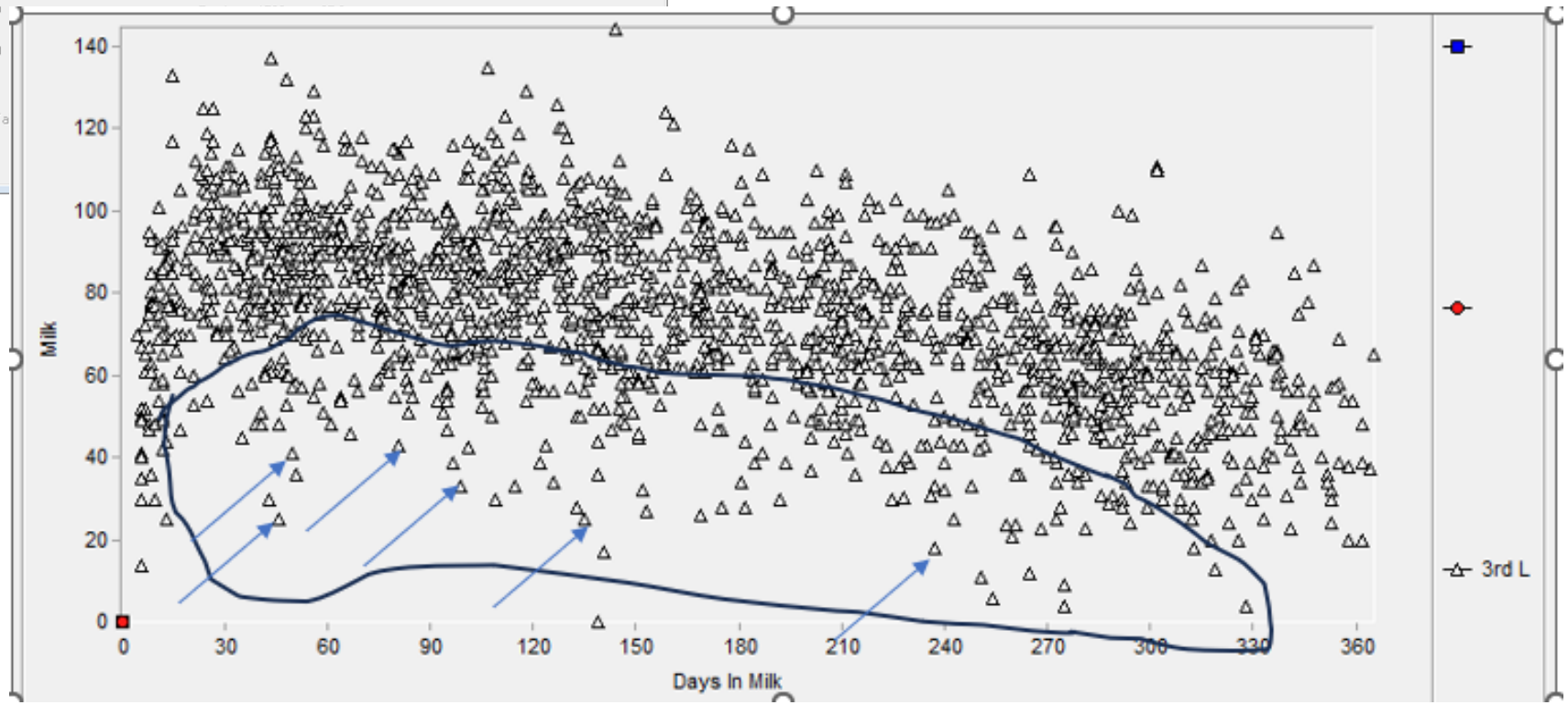
Using a Scattergraph of Milk by DIM is a super handy tool

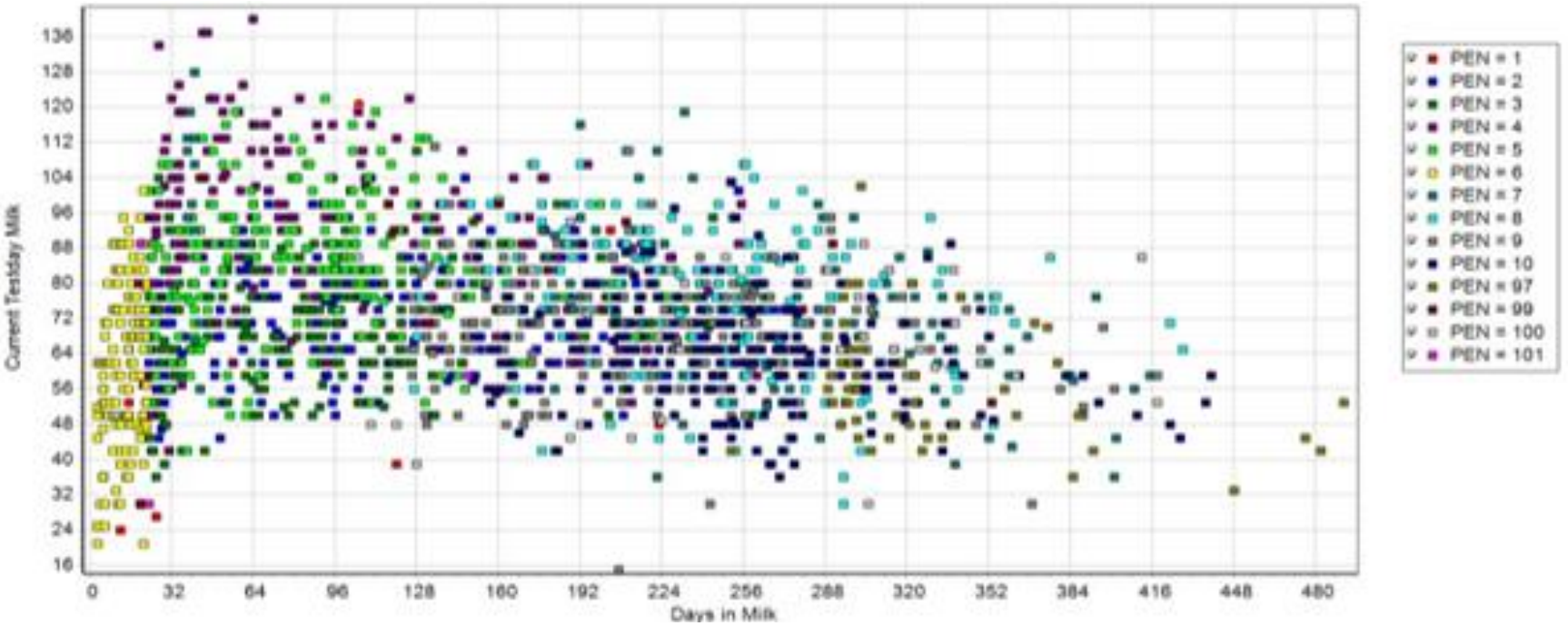
Graph milk by DIM for Lact>0 for Lctgp=3



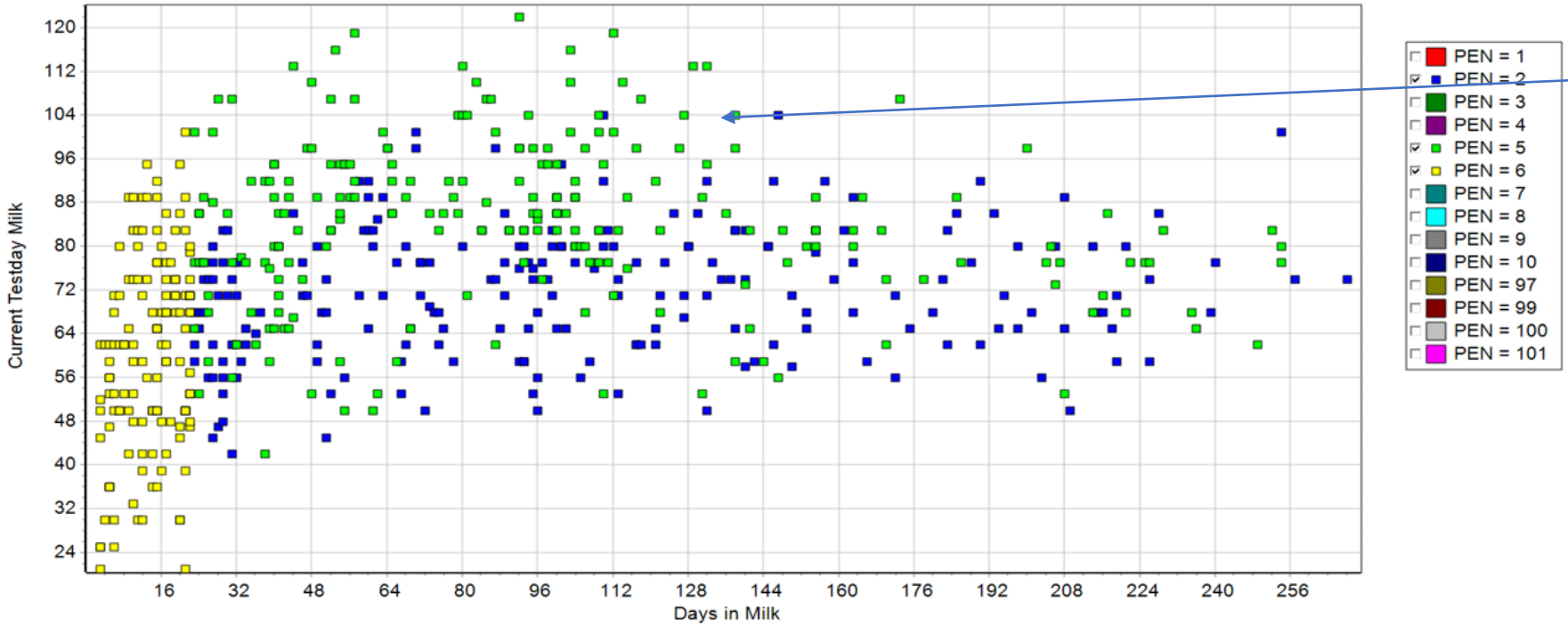
Underperforming

After intervention
Changes within transition



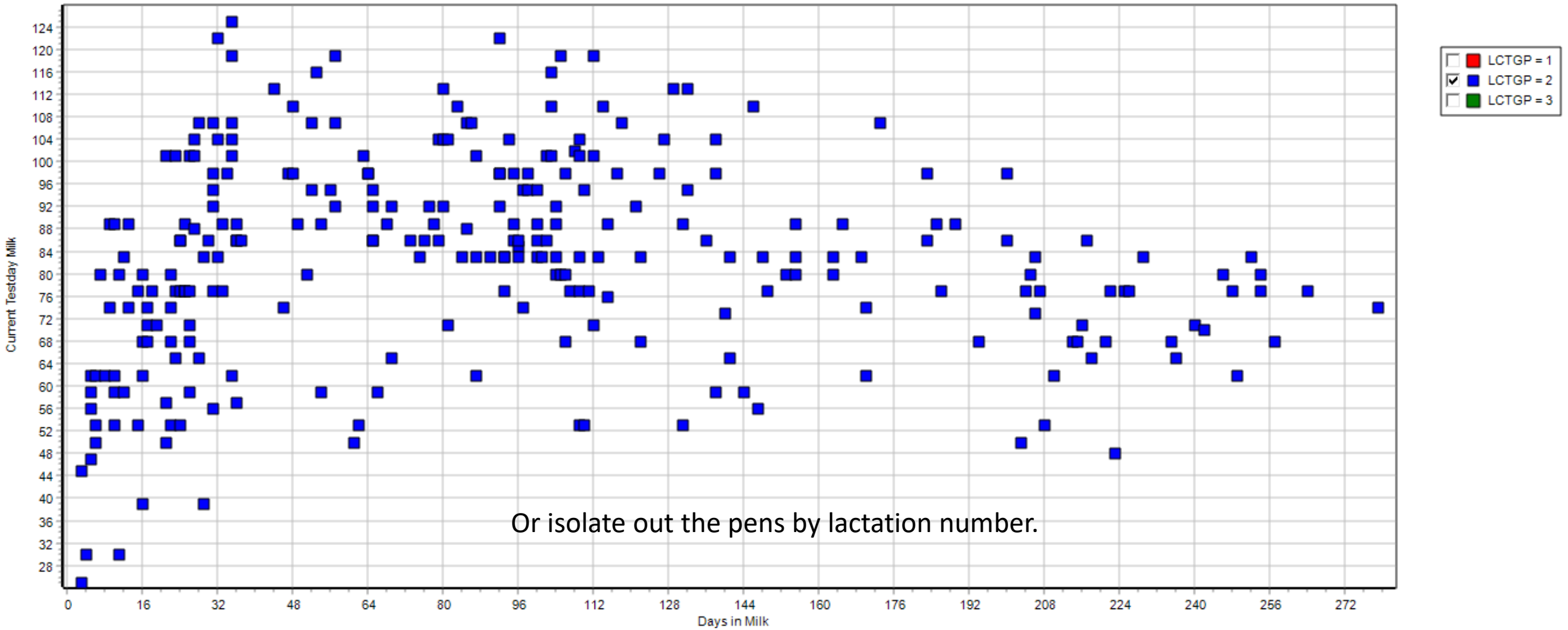


Reducing the animals for a clearer picture helps dive in on the problems.



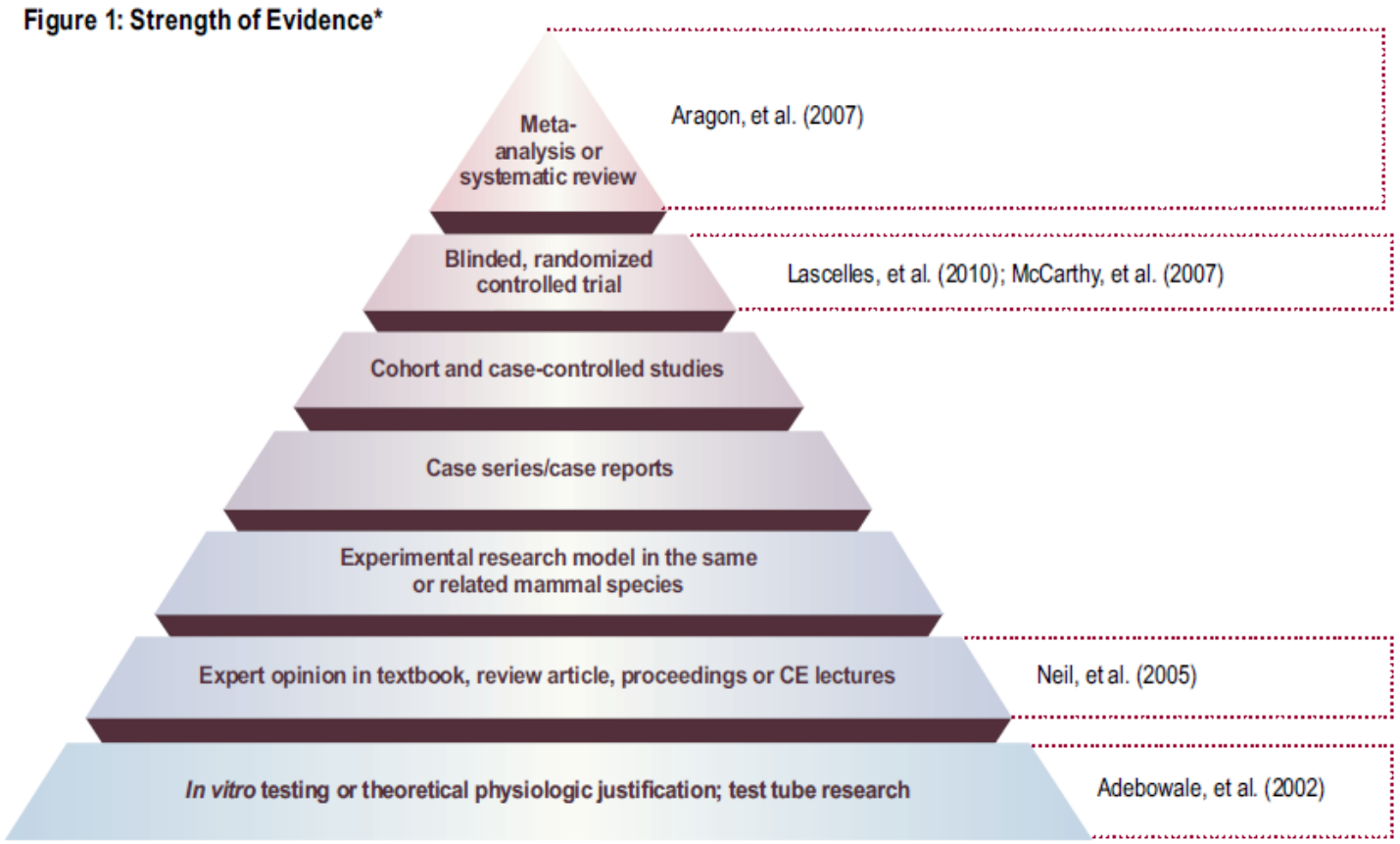
Pen 2 Green
Vs Pen 5 Blue

Graph Milk by DIM by Lctgp for Pens 1-6 2nd Lact



Intervention Accuracy

- Once we discover or have a theory of an area to intervene in
  - How do we choose an intervention
  - Levels of information hierarchy.



Type I and Type II Error

- A type I error is a false positive conclusion. I think the feed additive will increase milk by 5 # of milk when in fact it doesn't.
- A type II error is a false negative. I think the additive salesman is full of baloney, I am not putting it in the ration, while in fact, it would have given you 5 # of milk.
- An important note in looking at research. A *P*-value of < 0.05 means I am pretty sure the mean value is not 0. It doesn't tell you it's is 5 #.
- You need a confidence interval to see that.

In medicine we emphasize minimizing Type I error.

- We don’t want an intervention we are relying on for a life saving action to actually not be effective.

In Production Agriculture we deal with both types of error.

Usually, a treatment is not life threatening. Instead, it is about increasing income.

The cost of making an error is usually the cost of losing money.

- The product cost $0.10 /cow. It doesn't work at all on a 1000 cow dairy that's $100 per day of loss.
- If the milk price is $20 per CWT and the product increased milk by .5# then it is only a cost of $50 / day. If it made 1# there is no cost.

The money loss is a distribution of outcomes.

Type II error in Production medicine

- The Type II error is what am I giving up by making the wrong decision.
- If we don’t use the product and it really would have produced good results we make an error.
- The product would have given us 5# of milk. In this case the error cost for the same dairy is leaving $0.90/ day on the table, ($1.00 -$0.10)
- What if it didn’t perform as well as the salesperson claimed. It really only gave 2# of milk instead of the 5# they sold it on. In this case we still made $0.40 -$0.10= $0.30. So the cost of not using it is a $0.30 error.

Is it possible to calculate our potential for a Type 1 and Type 2 error

Yes

That's where randomized clinical trials come in.

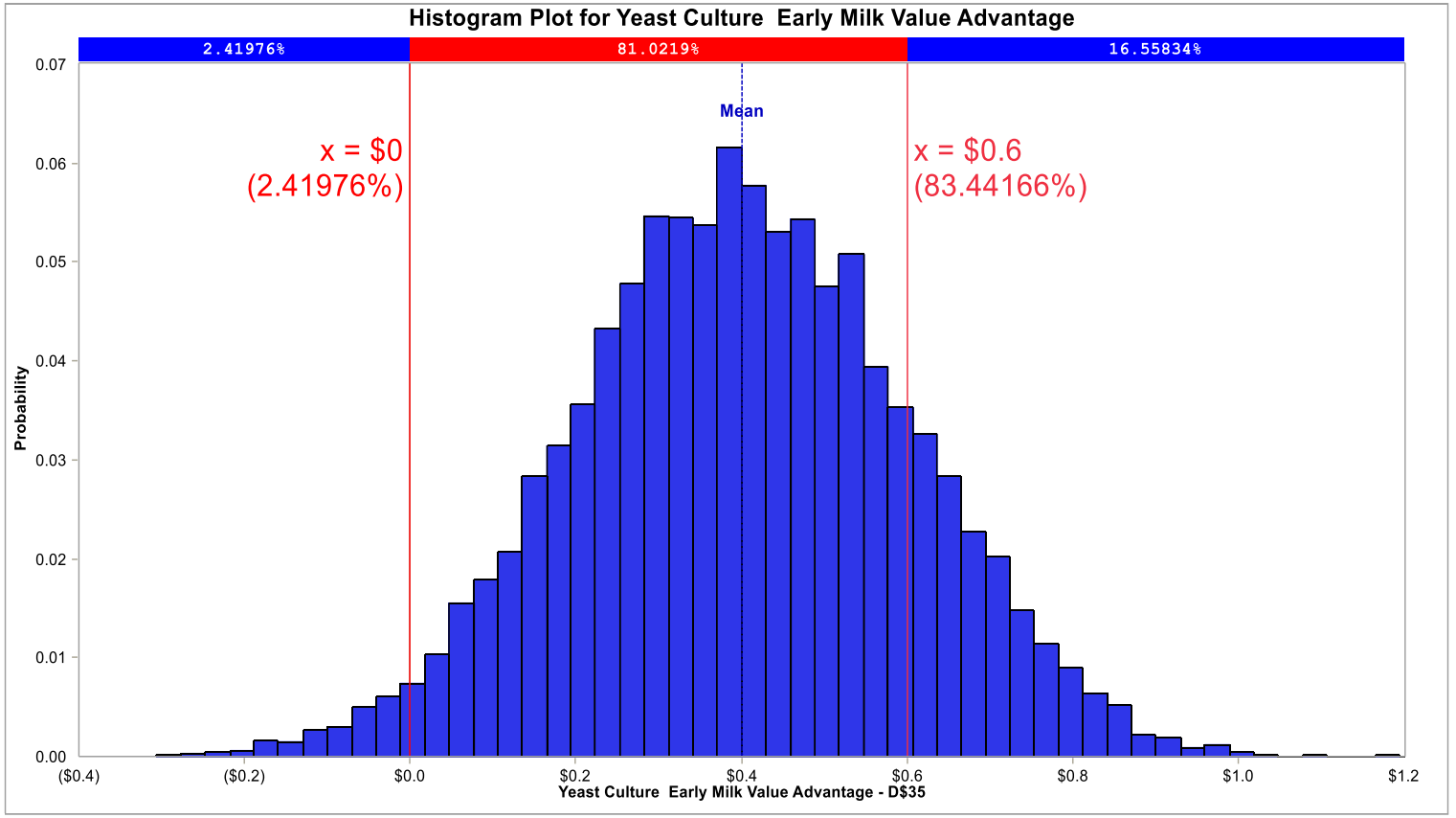
Let's say the result of an RCT is

- A mean difference between the treated and control group of 5 #
- The standard error of the mean is 2.
- We assume that means that 68% of the studies would fall between 3 and 7 #
- If another product that promised 5# had a SE of 4, then 68% would fall between 1 and 9.
- We can calculate this as the risk of the product.

Monte Carlo Simulation

Probability of being less than breakeven $0 return is 2.42%

The probability of being between 0$ and $0.60 is 81%

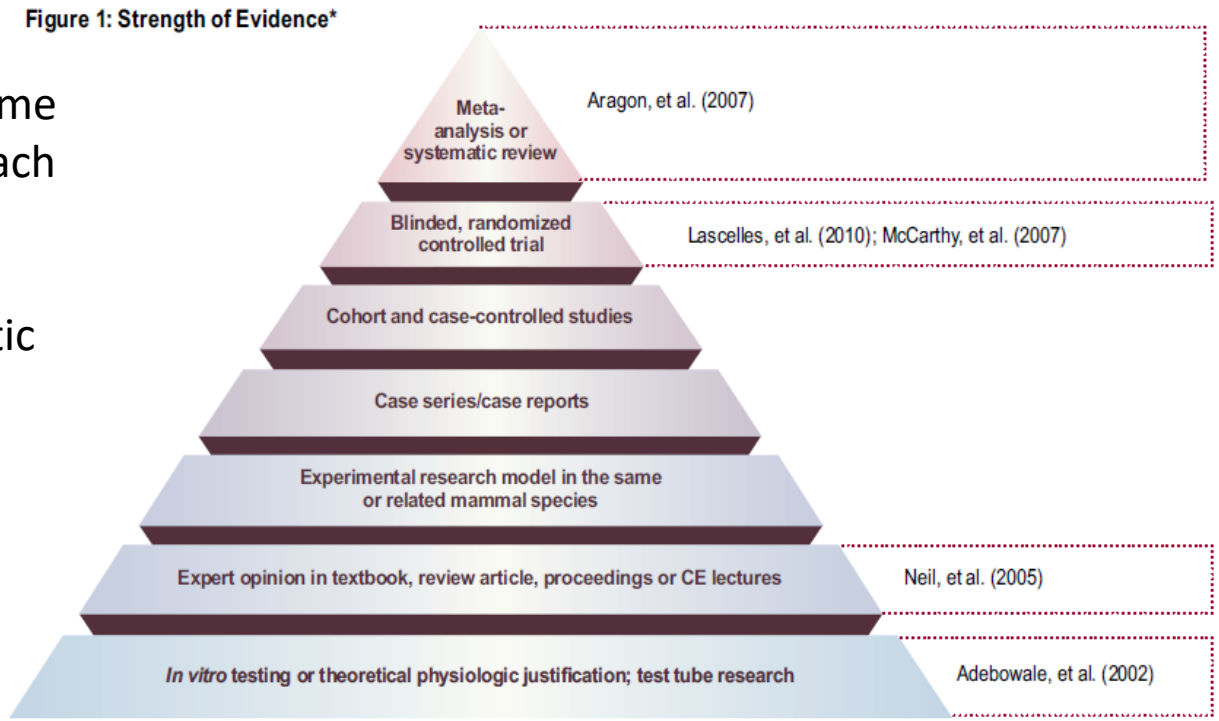


ModelRisk 5.1.1 (Vose Software BVBA, Belgium, 2015)
Yeast Culture using values from the meta-analysis

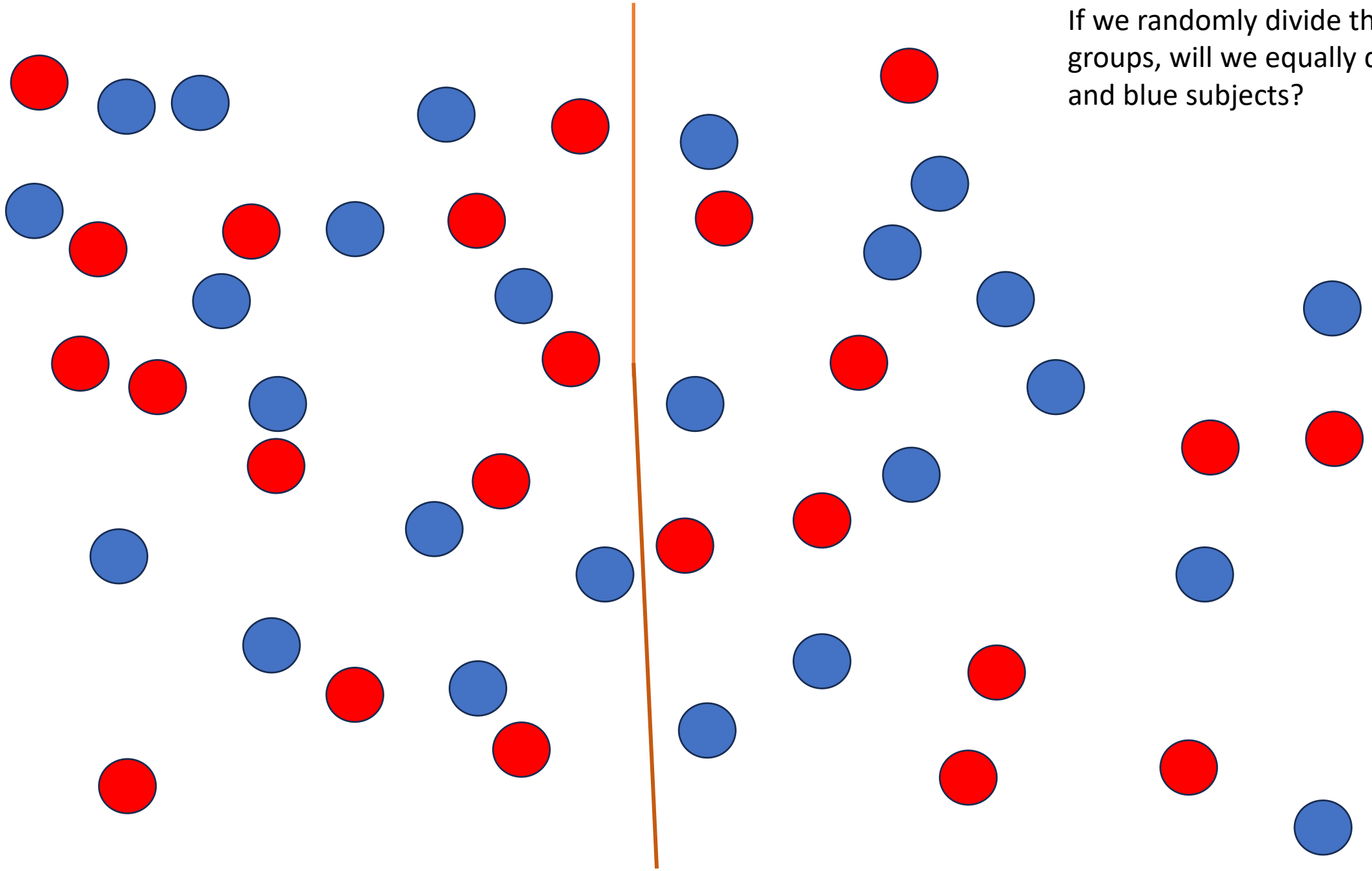
Returning to Hierarchy of evidence

- A blinded randomized controlled study is so good because it randomizes the unknown variables to both treatments.

We may be able to make sure we have the same number of heifers and multiparous cows in each group,
but what about cows that have a titer to IBR, or have fatty liver, or are carrying a genetic variation on butter fat response.
We hope we randomize these cows to both treatments by luck.



If we randomly divide the group into 2 groups, will we equally divide the red and blue subjects?



$$CI = \hat{x} \pm Z^* \frac{s}{\sqrt{n}}$$

Do a 2nd study

- If we do another study, if we had a true randomization of the confounding factors we think we have a 95% chance the true mean will fall within the confidence interval of the 1st trial.

$$SEM_N = \frac{s}{\sqrt{N}}$$

- Because the SEM gets small the more N we have in the study we get more precision

Meta-analysis

- A meta-analysis is a random sample of all possible trials of the specific intervention.
- We can think of the studies that same as the random balls in the RCT example only instead of individual cows they are published studies.
- The N then is the number of studies done with the average of the mean.
- The studies are weighted by how big the studies were. (inverse of the SE). We know smaller standard error studies should be given more weight than smaller studies.

What can go wrong with meta-analysis

- The biggest problem can be if sample is not a random sample of all possible studies.
- Most meta-analysis try to use all studies in existence to calculate their outcomes.
  - Some problems are when studies are not peer reviewed.
  - What if the studies were not well designed RCT trials.
  - Some studies can't get published as peer review if the are not well designed but companies use them anyway.
  - Some studies don't get published because they are tossed because they didn't have good outcomes. (Deskdrawer Bias). So, we are left with a biased sample of studies

Publication bias with meta-analysis

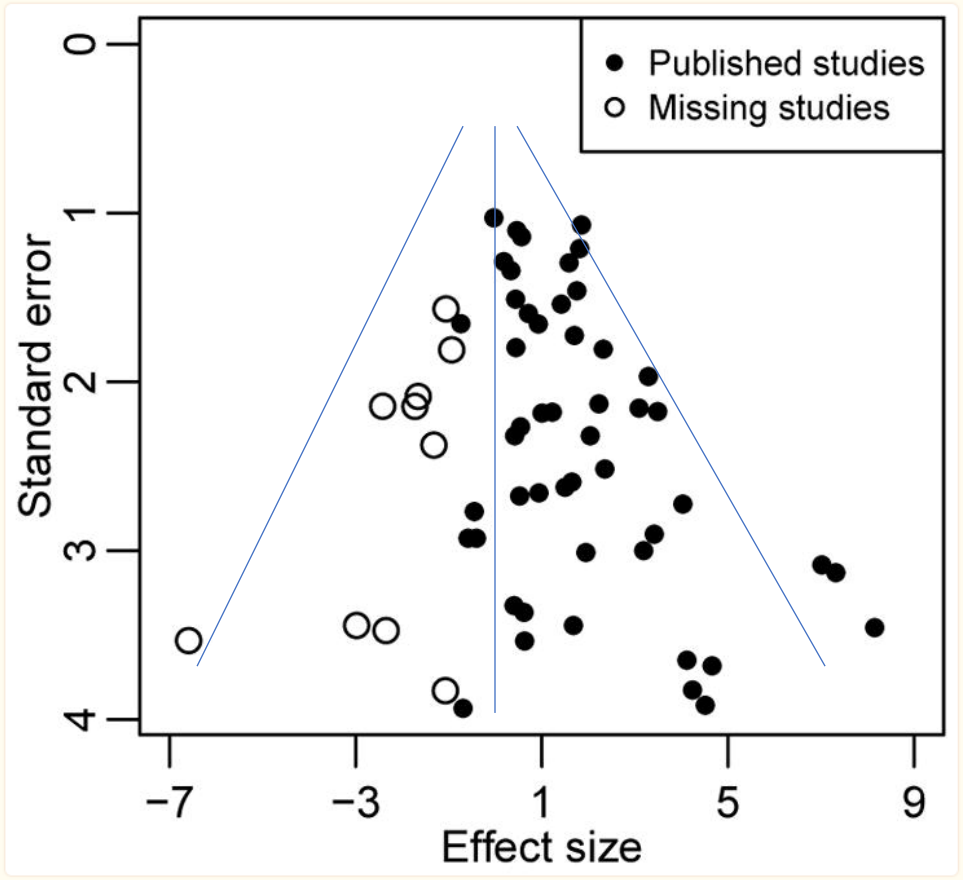


Figure 1

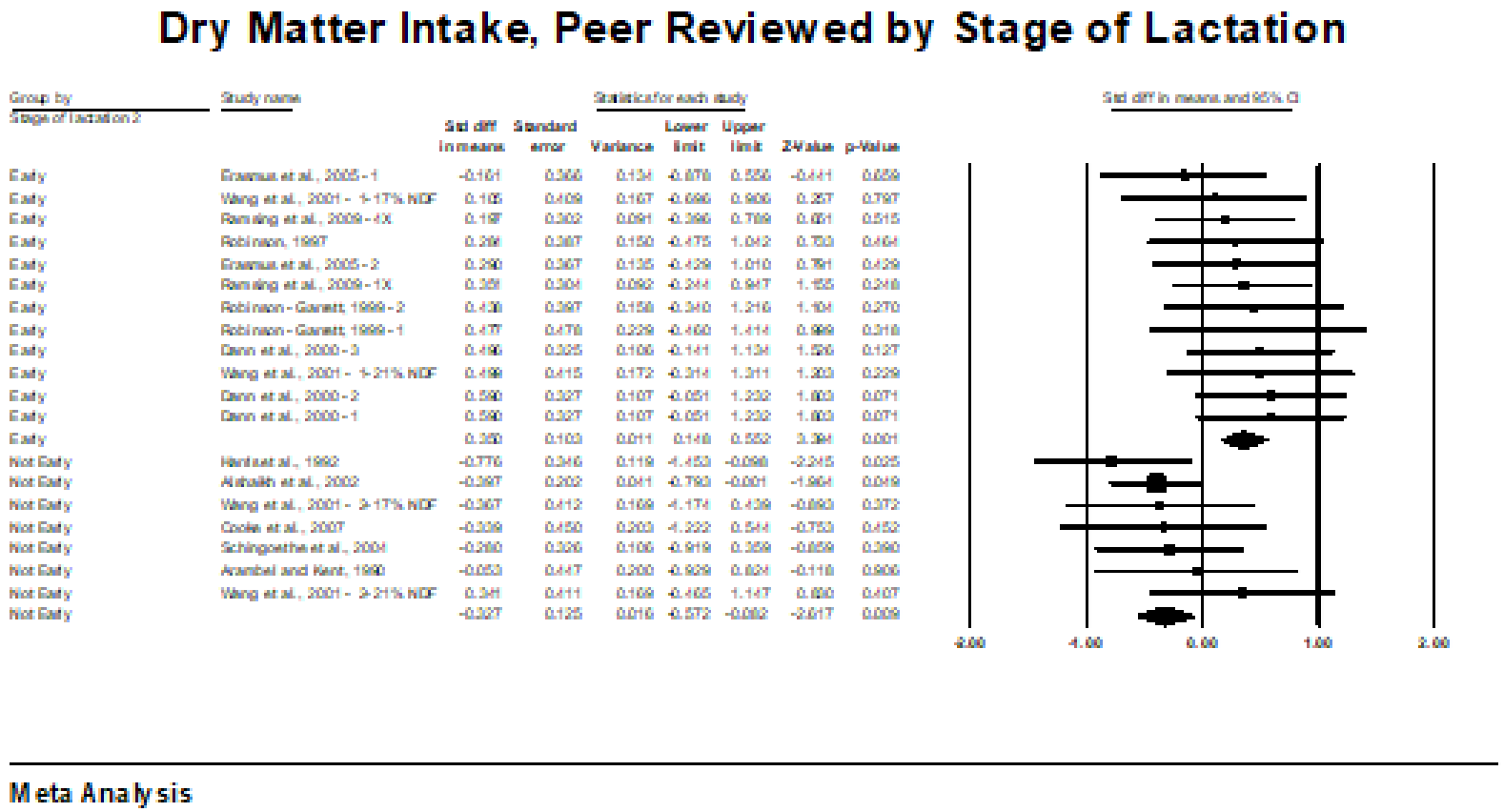
The funnel plot of a simulated meta-analysis containing 60 studies. The 10 studies with the most negative effect sizes were suppressed due to publication bias, and the remaining 50 studies were "published".

Unique component (the funnel plot) of meta-analysis is the ability to quantify publication bias

Quantifying Publication Bias in Meta-Analysis
Lifeng Lin and Haitao Chu Biometrics. 2018 Sep; 74(3): 785–794.

Heterogeneity and meta-analysis

- Probably the most powerful tool in meta-analysis



There are obviously 2 different effects occurring based on early and late DIM cows.
Within a straight summary of the outcomes the difference in the effects would be lost

Conclusion

- I believe the goal should be to help the dairy increase in profitability.
- Making the best decisions with less uncertainty helps us achieve this goal.
- Cutting and slicing the data, helps to see variation within populations we wouldn’t have seen.
- Using RCT and meta-analysis can help us quantify the uncertainty in intervention decisions.