POWER for Poultry

Pen-size **O**ptimization **W**orkbook for **E**xperimental **R**esearch design

User Guide

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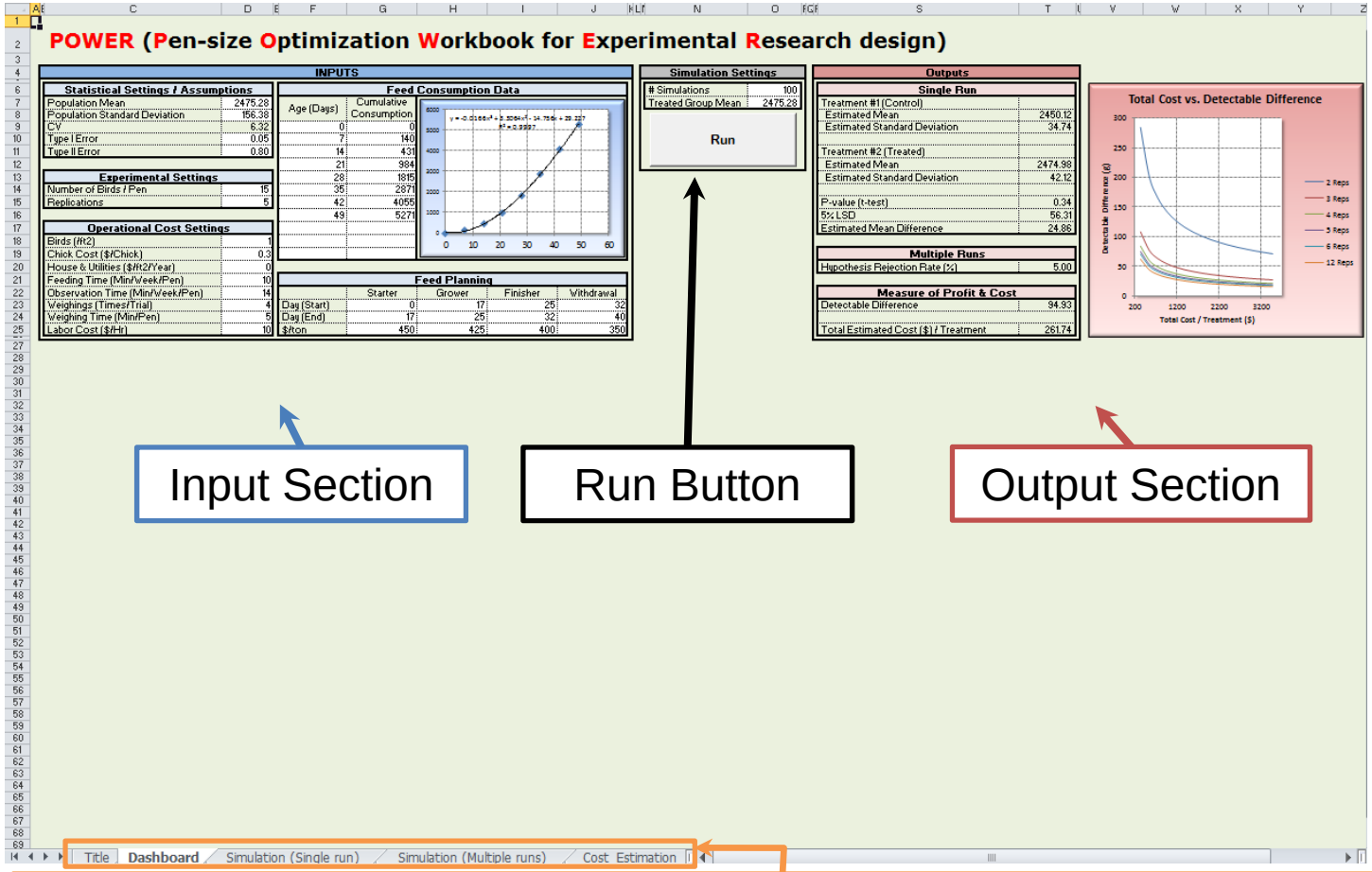
Tool Overview



Tab Description

1) Title
2) Dashboard – it represents summary of inputs & outputs. All inputs should be controlled in this tab.
3) Simulation (Single run) – it shows a simulated experiment based on the specified inputs.
4) Simulation (Multiple runs) – it conducts multiple simulations with a normal distribution assumption of population mean.
5) Cost_Estimation – it includes your cost estimation tool. (Experiment Cost.xls)
6) TC vs. DD – it has tables and chart about relationships between total cost and detectable difference.
7) Chart 1 – chart about relationships between total cost and detectable difference.
8) Chart 2 – chart about relationships between birds per pen and detectable difference.

[Step 1] Set-up Inputs

① Specify Assumptions and Statistical Settings

② Decide # of Birds/Pen and Replications

③ Type good numbers for cost estimation

POWER (Pen-size Optimization Workbook for Expe

INPUTS

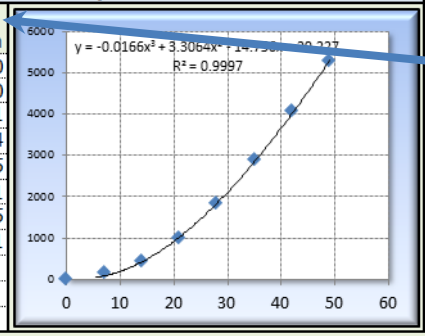
Statistical Settings / Assumptions	
Population Mean	2475.28
Population Standard Deviation	156.38
CV	6.32
Type I Error	0.05
Type II Error	0.80

Experimental Settings	
Number of Birds / Pen	15
Replications	5

Operational Cost Settings	
Birds (/ft2)	1
Chick Cost ($/Chick)	0.3
House & Utilities ($/ft2/Year)	0
Feeding Time (Min/Week/Pen)	10
Observation Time (Min/Week/Pen)	14
Weighings (Times/Trial)	4
Weighing Time (Min/Pen)	5
Labor Cost ($/Hr)	10

Feed Consumption Data

Age (Days)	Cumulative Consumption
0	0
7	140
14	431
21	984
28	1815
35	2871
42	4055
49	5271



Feed Planning

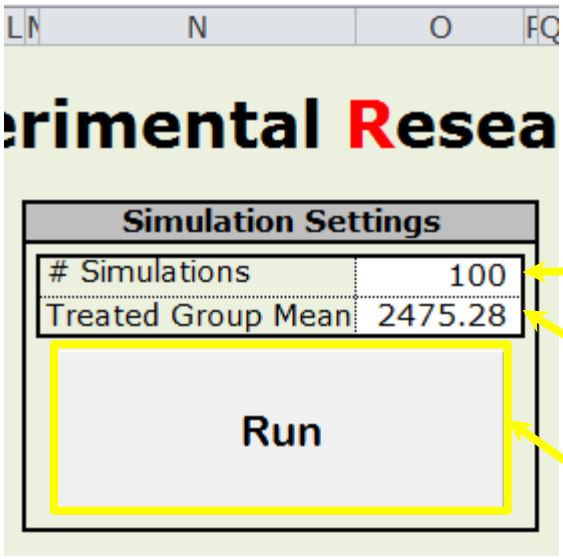
	Starter	Grower	Finisher	Withdrawal
Day (Start)	0	17	25	32
Day (End)	17	25	32	40
$/ton	450	425	400	350

④ Proper historical data should be typed in. Graph will be automatically adjusted.

⑤ Modify this table as the experiment plan. E.g., if you don't want to use Grower feed, just empty 'Grower' column and adjust 'Starter' column. If you use up to 'Withdrawal', just fill out every cell. Cost calculation will automatically take care of them w/o any equation corrections in the other sheets manually.

c.f.) Current values of 'Population Mean' and 'Population Standard Deviation' typed in the Workbook are average female body weight and its standard deviation on Day 48th from Individual Broiler Experiment in M-house.

[Step 2] Click Run Button



① Set up the number of simulations.

② Set up the mean value of a treated group. It is an assumption for the simulation to see how accurate the result will be based on the input settings from Step 1.

③ Click it after all values are set up.

c.f.) '# Simulations' above the 'Run' button is for multiple simulations. Once the button is hit, the 'Simulation (Multiple runs)' worksheet shows you how P-value varies based on the assumption of a normal distribution for the population mean. (like Monte-Carlo Simulation)

[Step 3] Reading Outputs

① 'Simulation Results' shows the summary of the second worksheet, Simulation (Single run).

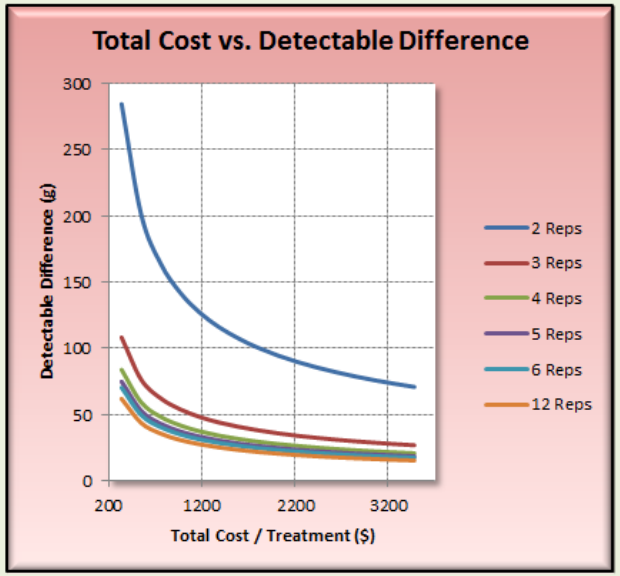
② Probability of hypothesis rejection (Null hypo. : Control = Treated)

③ Detectable Difference and Total Estimated Cost/Treatment is presented.

QP S T U V W X Y Z

arch design)

Outputs	
Single Run	
Treatment #1 (Control)	
Estimated Mean	2450.12
Estimated Standard Deviation	34.74
Treatment #2 (Treated)	
Estimated Mean	2474.98
Estimated Standard Deviation	42.12
P-value (t-test)	0.34
5% LSD	56.31
Estimated Mean Difference	24.86
Multiple Runs	
Hypothesis Rejection Rate (%)	5.00
Measure of Profit & Cost	
Detectable Difference	94.93
Total Estimated Cost ($) / Treatment	261.74



③ Total costs ($366.4048 ~ $3505.333) and detectable differences against various numbers of birds per pen and replications which make from 120 to 1920 total birds.

[Step 4] Check the Other Worksheets

‘Simulation (Single run)’ Worksheet

Randomly generated ‘Individual Bird Weight’ along normal distribution

Each Replication

	A	B	C	D	E	F	G	H	I	J	K	L
1		Control						Treated				
2		Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5		Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5
3	Bird #1	2559.79	2624.37	2439.73	2480.67	2249.00		2488.40	2621.19	2440.81	2460.75	2279.64
4	Bird #2	2506.66	2510.53	2563.07	2416.49	2407.22		2388.54	2819.30	2404.84	2437.62	2297.84
5	Bird #3	2394.15	2685.88	2528.49	2379.32	1929.46		2593.28	2358.12	2347.84	2226.19	2489.72
6	Bird #4	2131.75	2555.10	2335.68	2366.75	2538.53		2586.10	2796.46	2508.20	2793.52	2492.57
7	Bird #5	2615.17	2366.80	2256.30	2233.34	2622.90		2561.38	2488.57	2458.77	2431.72	2257.53
8	Bird #6	2210.73	2280.42	2680.91	2421.31	2339.10		2441.32	2982.87	2375.33	2471.32	2547.94
9	Bird #7	2646.07	2546.75	2598.81	2316.95	2457.29		2601.65	2138.77	2427.06	2465.26	2417.98
10	Bird #8	2424.85	2504.93	2388.59	2373.35	2313.19		2752.67	2274.92	2694.35	2526.66	2559.27
11	Bird #9	2652.50	2277.54	2527.90	2491.80	2704.66		2227.08	2606.27	2526.20	2317.37	2487.13
12	Bird #10	2731.83	2386.21	2447.08	2716.52	2265.27		2420.90	2211.22	2273.05	2537.44	2584.59
13	Bird #11	2485.03	2391.37	2499.30	2477.67	2436.41		2589.34	2428.33	2554.82	2431.79	2460.31
14	Bird #12	2223.23	2393.71	2688.58	2281.27	2472.21		2511.85	2730.36	2627.50	2598.16	2347.88
15	Bird #13	2463.00	2795.90	2162.17	2459.43	2406.37		2392.45	2436.22	2492.31	2582.58	2270.73
16	Bird #14	2524.16	2383.33	2691.04	2513.32	2510.78		2534.62	2320.05	2447.80	2626.19	2325.99
17	Bird #15	2376.50	2321.57	2547.52	2149.99	2703.32		2383.83	2534.10	2476.24	2349.37	2273.01
18												
19	Average	2463.03	2468.29	2490.34	2405.21	2423.71		2498.23	2516.45	2470.34	2483.73	2406.14
20	Std.	174.21	152.31	155.92	133.99	196.59		126.81	242.83	106.14	137.44	118.08
21	CV	7.07	6.17	6.26	5.57	8.11		5.08	9.65	4.30	5.53	4.91
22												
23	Total Aver.	2450.12						2474.98				
24	Total Std.	34.74						42.12				
25	Total CV	1.42						1.70				
26												
27	P-Value	0.34										

Treatments

[Step 4] Check the Other Worksheets

‘Simulation (Multiple runs)’ Worksheet

Weight Aver. of one pen from randomly generated birds.

Pen weight average & standard deviation.

Average mean difference.

T and P values based on # of replications

Reject if this value is 1

Each row shows one experiment.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1																					
2		Pr(Reject Null Hypothesis) =			5	5.00	%					# if the population mean of treated group is		2475.28							
3		Null Hypothesis :			Treated = Control																
4																					
5																					
6		Replications																			
7	Experiment	Controlled								Treated											
8	Simulations	1	2	3	4	5	Aver.	Std.		1	2	3	4	5	Aver.	Std.		Difference	t-Value	P-Value	<.05
9	Exp. #1	2427.72	2485.55	2465.48	2456.35	2455.26	2458.07	20.87		2469.48	2521.12	2457.52	2482.14	2480.35	2482.12	23.92		24.05	1.69387017	0.128741375	0
10	Exp. #2	2549.56	2506.66	2530.37	2502.41	2453.88	2508.58	36.01		2429.18	2430.18	2430.68	2445.01	2439.29	2434.87	6.97		-73.71	-4.4933361	0.002019815	1
11	Exp. #3	2517.88	2488.98	2449.92	2508.96	2500.67	2493.29	26.48		2488.88	2472.70	2447.08	2442.55	2476.28	2465.50	19.88		-27.79	-1.8766001	0.097413548	0
12	Exp. #4	2477.05	2482.36	2514.77	2458.71	2443.10	2475.20	27.03		2474.25	2438.56	2433.81	2472.62	2396.37	2443.12	32.14		-32.08	-1.7080661	0.126004463	0
13	Exp. #5	2499.37	2438.66	2518.73	2429.21	2487.05	2474.60	38.95		2555.63	2459.03	2453.89	2407.96	2453.27	2465.96	54.22		-8.64	-0.2895461	0.779525863	0
14	Exp. #6	2495.66	2531.83	2472.59	2547.56	2453.73	2500.28	39.33		2452.73	2468.67	2562.20	2520.34	2510.06	2502.80	43.47		2.53	0.09631269	0.92564126	0
15	Exp. #7	2398.95	2425.16	2449.03	2468.81	2512.30	2450.85	43.18		2478.98	2489.28	2492.04	2442.06	2517.33	2483.94	27.33		33.09	1.44806208	0.185629493	0
16	Exp. #8	2467.63	2463.64	2457.23	2543.08	2510.24	2488.36	37.02		2467.64	2465.22	2471.64	2454.75	2438.47	2459.54	13.33		-28.82	-1.6376101	0.140137956	0
17	Exp. #9	2514.16	2492.57	2464.69	2557.74	2472.97	2500.42	37.30		2432.39	2503.72	2495.96	2460.53	2500.57	2478.64	31.13		-21.79	-1.0027843	0.345327835	0
18	Exp. #10	2500.42	2519.46	2485.66	2486.75	2427.98	2484.05	34.19		2448.98	2443.18	2453.50	2568.33	2469.88	2476.77	52.14		-7.28	-0.2611012	0.80061027	0
19	Exp. #11	2468.06	2556.03	2455.28	2394.88	2476.18	2470.09	57.67		2497.93	2473.32	2445.13	2478.43	2457.67	2470.49	20.20		0.41	0.01487957	0.988492645	0
20	Exp. #12	2438.15	2492.85	2451.13	2529.95	2452.72	2472.96	37.88		2527.30	2502.30	2461.84	2459.36	2494.61	2489.08	28.68		16.12	0.75856189	0.46987041	0
21	Exp. #13	2435.84	2490.80	2477.27	2462.19	2495.22	2472.26	24.10				8		2492.41	2553.78	2501.02		38.25	28.76	1.42237757	0.192714328	0
22	Exp. #14	2434.59	2552.28	2458.72	2518.02	2453.20	2483.36	49.61				7		2479.41	2462.54	2470.26		21.79	-13.10	-0.5405953	0.603507647	0
23	Exp. #15	2436.75	2464.71	2480.36	2494.38	2491.63	2473.57	23.66				5		2519.91	2498.57	2485.29		59.88	11.72	0.40697651	0.694696528	0
24	Exp. #16	2500.37	2506.76	2470.41	2488.02	2459.15	2484.94	20.00				4		2457.72	2504.76	2485.48		37.57	0.54	0.02844266	0.978005837	0
25	Exp. #17	2523.16	2475.35	2483.12	2468.12	2462.25	2482.40	24.09				8		2464.84	2432.81	2481.22		38.21	-1.18	-0.0585155	0.954773252	0
26	Exp. #18	2497.58	2457.21	2471.60	2538.08	2397.09	2472.31	52.08		2432.91	2422.28	2414.63	2487.87	2442.45	2440.03	28.75		-32.29	-1.2135167	0.259541691	0
27	Exp. #19	2465.13	2516.48	2450.06	2488.90	2491.99	2482.51	25.69		2436.19	2504.80	2534.75	2472.00	2487.52	2487.05	36.76		4.54	0.22645977	0.826522958	0
28	Exp. #20	2483.25	2509.41	2524.84	2550.41	2440.52	2501.68	41.98		2507.66	2539.51	2485.16	2452.82	2495.17	2496.06	31.67		-5.62	-0.2389768	0.817131885	0
29	Exp. #21	2488.04	2499.41	2479.93	2438.67	2397.70	2460.75	42.04		2474.20	2486.21	2498.79	2420.72	2516.13	2479.21	36.20		18.46	0.74403538	0.478136889	0
30	Exp. #22	2506.36	2491.20	2548.38	2490.53	2370.88	2481.47	66.15		2409.80	2491.32	2533.96	2526.50	2473.33	2486.98	49.83		5.51	0.14880604	0.885389353	0
31	Exp. #23	2484.34	2453.25	2568.96	2530.14	2483.49	2504.04	45.51		2520.36	2514.21	2417.84	2533.48	2512.20	2499.62	46.46		-4.42	-0.1519203	0.883011147	0
32	Exp. #24	2412.41	2494.48	2402.49	2472.51	2450.39	2446.45	39.03		2482.76	2469.64	2524.86	2531.31	2511.15	2503.95	26.76		57.49	2.71668331	0.026383777	1
33	Exp. #25	2483.59	2420.75	2479.50	2429.69	2410.45	2444.80	34.26		2423.27	2488.76	2491.10	2480.89	2511.91	2479.18	33.30		34.39	1.60946898	0.146180077	0
34	Exp. #26	2471.14	2457.91	2476.00	2437.56	2504.25	2469.37	24.53		2447.80	2504.08	2540.32	2515.24	2502.02	2501.89	33.86		32.52	1.739252	0.120180923	0
35	Exp. #27	2546.50	2526.30	2538.15	2423.81	2509.45	2508.84	49.53		2455.18	2443.96	2468.79	2468.00	2514.49	2470.08	26.84		-38.76	-1.5383765	0.162516145	0
36	Exp. #28	2453.74	2431.21	2468.32	2487.78	2477.73	2463.76	22.09		2521.55	2439.26	2556.88	2474.93	2418.83	2482.29	57.09		18.53	0.67695615	0.517526049	0
37	Exp. #29	2489.37	2472.93	2481.46	2462.42	2430.75	2467.39	22.80		2424.93	2499.04	2523.98	2452.57	2424.85	2465.07	44.75		-2.31	-0.1030052	0.920494094	0
38	Exp. #30	2488.27	2505.26	2461.45	2435.35	2402.34	2458.53	41.15		2520.69	2506.30	2527.78	2513.74	2510.69	2515.84	8.49		57.31	3.05012273	0.015818087	1
39	Exp. #31	2454.49	2411.68	2494.09	2457.64	2516.93	2466.97	40.41		2485.48	2457.22	2452.76	2442.46	2448.14	2457.21	16.72		-9.75	-0.4987212	0.631397523	0
40	Exp. #32	2468.94	2444.70	2425.50	2496.00	2509.36	2468.90	34.78		2452.55	2410.37	2470.84	2386.09	2511.47	2446.26	49.51		-22.64	-0.8364798	0.427162539	0
41	Exp. #33	2485.64	2472.23	2452.43	2403.95	2466.58	2456.17	31.53		2466.04	2448.02	2468.21	2459.57	2489.52	2466.27	15.19		10.10	0.64568426	0.536559965	0
42	Exp. #34	2422.01	2475.35	2436.01	2444.77	2440.38	2443.70	19.64		2464.56	2432.04	2520.39	2423.06	2445.78	2457.17	38.65		13.46	0.69430822	0.507146932	0
43	Exp. #35	2442.95	2482.17	2449.27	2467.28	2607.82	2489.90	67.70		2552.36	2476.21	2468.27	2541.29	2557.44	2519.11	43.28		29.22	0.81312321	0.439674084	0
44	Exp. #36	2548.62	2430.41	2459.50	2465.63	2525.91	2486.01	49.30		2436.62	2553.02	2443.04	2308.58	2506.34	2449.52	92.21		-36.49	-0.7804146	0.457614045	0
45	Exp. #37	2462.11	2484.77	2491.72	2492.16	2452.42	2476.64	18.25		2554.60	2445.94	2466.43	2422.98	2486.78	2475.35	50.25		-1.29	-0.0539455	0.958301428	0

[Step 4] Check the Other Worksheets

‘Cost_Estimation’ Worksheet

EXPEIMENTAL COSTS PLANNING SPREADSHEET

Enter coefficients for the equation: Consumption = $b_0 + b_1 \times Age + b_2 \times Age^2 + b_3 \times Age^3$

b_0	29.227273
b_1	-14.75567
b_2	3.3063875
b_3	-0.016572

DON'T OVERWRITE THIS SHEET
VALUES COME FROM THE DASHBOARD

FEED COSTS	Starter	Grower	Finisher	Withdrawal	Total
Age at Start (Days)	0	17	0	0	
Age at End (Days)	17	24	0	0	
Consumption (Kg)	0.623	0.698	0.000	0.000	
$/ton (1000 Kg)	450	425	0	0	
Feed Cost per bird	0.280476	0.2966358	0	0	
TOTAL					0.577111476

Birds	/Ft^2	1
Chick Cost	$/Chick	0.3
House & Utilities	$/Ft^2/Year	5
Feeding Time	Minutes/week/pen	10
Observation Time	Minutes/week/pen	14
Weighings	Times/Trial	4
Weighing Time	Minutes/pen	5
Labor Cost	$/Hour	10

Birds per pen	15
Pens per treatment	6
Total Cost per treatment	$ 270.24

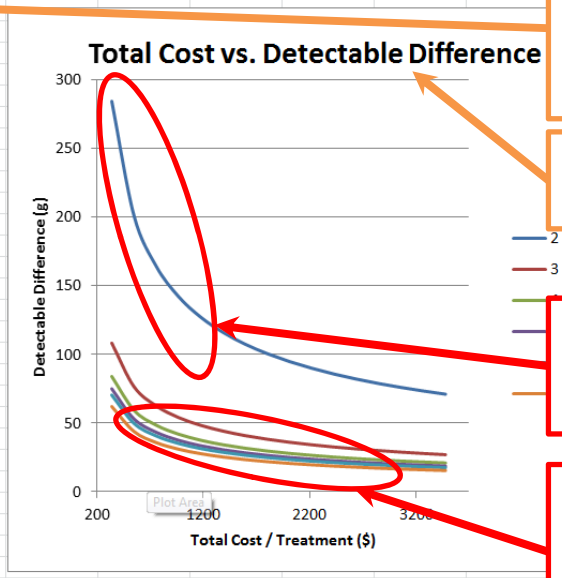
Per Treatment	
90	Total Chicks
$ 27.00	Total Chick Cost
$ 51.94	Total Feed Cost
3.43	Weeks of Age
206	Minutes of Feeding Labor
120	Minutes of Weighing Labor
288	Minutes of Observing Labor
614	Total Minutes of Labor
$ 102.29	Total Labor Cost
$ 89.01	Total Housing Cost (Asummes 2x floor space outside pens)

This tab represents calculation details on cost. Every input value is from ‘Dashboard’ worksheet.
DO NOT overwrite any value in this sheet.

[Step 4] Check the Other Worksheets

‘TC_vs_DD’ Worksheet

	Reps	Birds	Total Bird	TC	DD
3	2	60	120	340.214	284.307
4	2	120	240	549.476	201.036
5	2	180	360	758.738	164.145
6	2	240	480	968	142.154
7	2	300	600	1177.26	127.146
8	2	360	720	1386.52	116.068
9	2	420	840	1595.79	107.458
10	2	480	960	1805.05	100.518
11	2	540	1080	2014.31	94.7691
12	2	600	1200	2223.57	89.9059
13	2	660	1320	2432.83	85.7219
14	2	720	1440	2642.1	82.0724
15	2	780	1560	2851.36	78.8527
16	2	840	1680	3060.62	75.9843
17	2	900	1800	3269.88	73.4078
18	2	960	1920	3479.14	71.0768
20	3	40	120	340.214	108.278
21	3	80	240	549.476	76.5638
22	3	120	360	758.738	62.5141
23	3	160	480	968	54.1388
24	3	200	600	1177.26	48.4232
25	3	240	720	1386.52	44.2042
26	3	280	840	1595.79	40.9251
27	3	320	960	1805.05	38.2819
28	3	360	1080	2014.31	36.0925
29	3	400	1200	2223.57	34.2404



Total costs ($366.4048 ~ $3505.333) and detectable differences against various numbers of birds per pen and replications which make from 120 to 1920 total birds.

Chart on the right hand side shows the interesting information.

In 2 Reps, the increase in # birds decreases DD much, but still DDs are quite big.

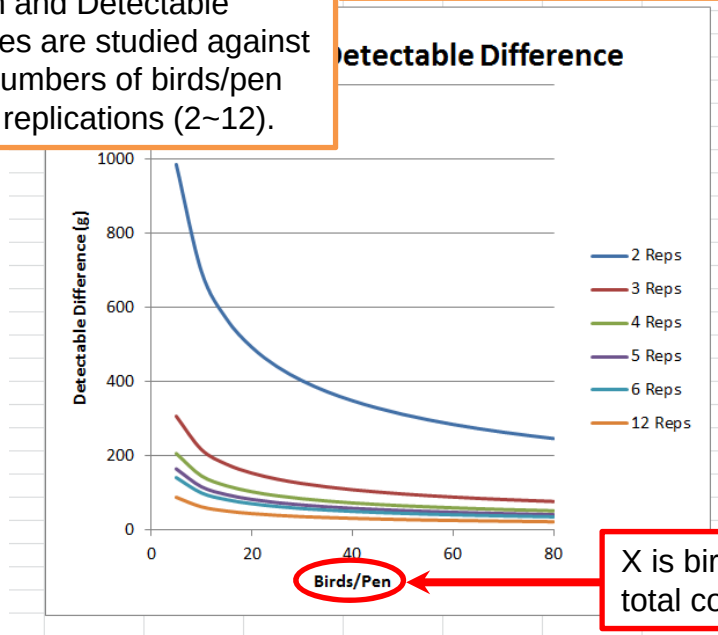
In 12 Reps, the increase in # birds does not affect DD much, and causes steep increase in total cost.

In order to have relatively small detectable difference with reasonable cost, proper trade-off study is necessary.

[Step 4] Check the Other Worksheets

‘TC_vs_DD’ Worksheet

Birds/pen and Detectable Differences are studied against various numbers of birds/pen (5~80) & replications (2~12).

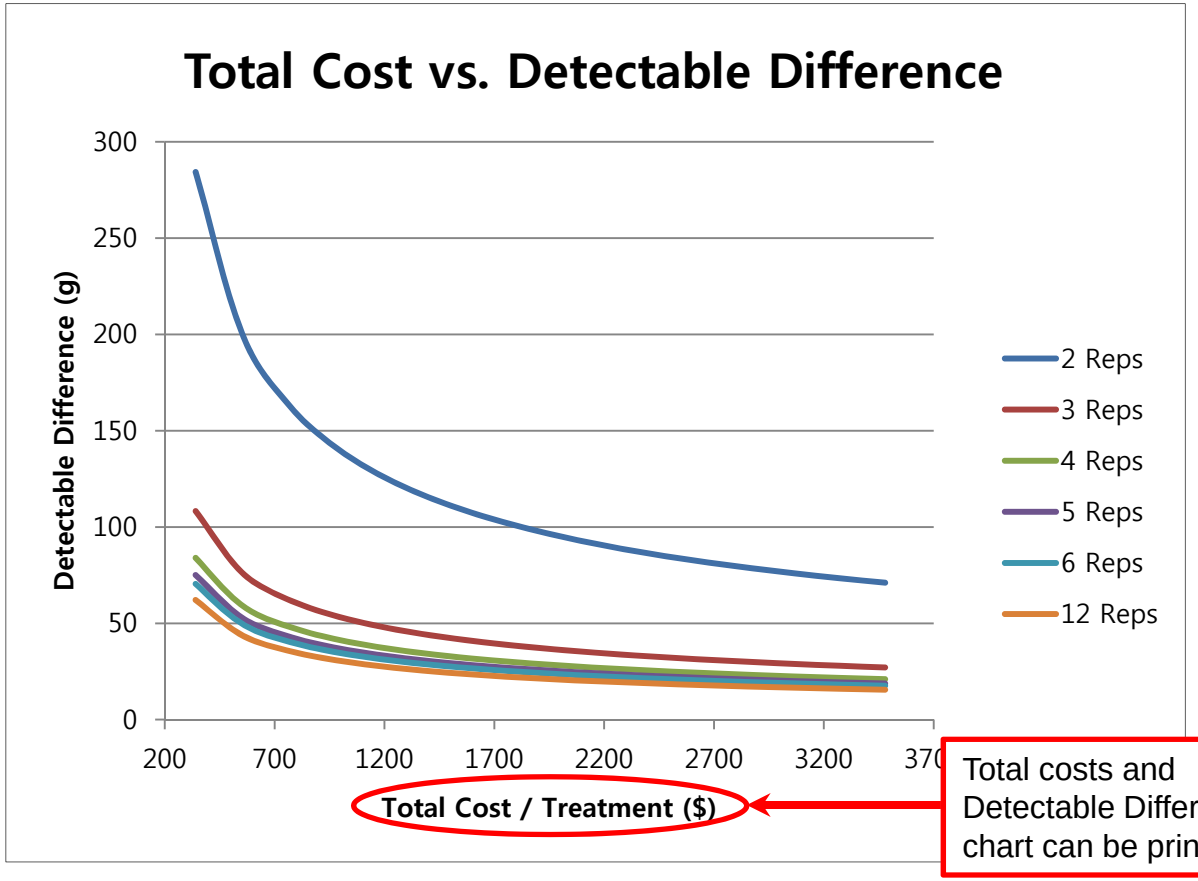


X is birds/pen instead of total cost/treatment ($)

Reps	Birds	Total Birds	TC	DD
3	55	165	418.688	92.3395
3	60	180	444.845	88.4083
3	65	195	471.003	84.94
3	70	210	497.161	81.8502
3	75	225	523.318	79.0748
3	80	240	549.476	76.5638
4	5	20	165.829	205.764
4	10	40	200.706	145.497
4	15	60	235.583	118.798
4	20	80	270.46	102.882
4	25	100	305.337	92.0207
4	30	120	340.214	84.003
4	35	140	375.091	77.7717
4	40	160	409.968	72.7487
4	45	180	444.845	68.5882
4	50	200	479.722	65.0684
4	55	220	514.599	62.0403
4	60	240	549.476	59.3991
4	65	260	584.353	57.0688
4	70	280	619.23	54.9929
4	75	300	654.107	53.1282
4	80	320	688.984	51.4411
	5	25	174.549	164.425
	10	50	218.145	116.266
	15	75	261.741	94.9306
	20	100	305.337	82.2123

[Step 5] Print Charts

'Chart 1' Worksheet



Total costs and Detectable Differences chart can be printed

[Step 5] Print Charts

'Chart 2' Worksheet