Conventional versus Pasture-Based Dairy Systems: An Economic Analysis

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Background

Recent years have reduced profits and increased volatility for many U.S. dairy families. This situation has resulted from increasing volatility in milk prices along with feed prices that have not only increased, but have also become more volatile (NASS 2010). This situation is even more pronounced in the Southeastern U.S., which as a grain-deficit region often experiences much higher grain prices than those in other parts of the country. Moreover, these increases in input costs create additional capital demands for producers. Throughout the U.S. the overall number of dairy operations decreased dramatically from 2001 to 2009, according to 2010 NASS numbers. Although the number of operations decreased by 33 percent during this time period, milk production increased by 15 percent. The higher milk production is contributed to less efficient operations exiting the industry and lower producing cows being culled from the herd. In the Southeast, however, both milk production and milk cow inventory decreased from 2001 to 2009 (NASS 2010). This decreased production and inventory, coupled with higher grain prices has led to reduced profits for Southeastern producers. To alleviate this problem, a considerable number of Southeastern U.S. dairy producers are considering production systems that can generate greater profits with lower capital requirements.

Two alternative production systems, both pasture-based, to the conventional confinement production system (CONV) are generating considerable interest in the region. The CONV system relies heavily on corn silage and grain concentrates to produce large quantities of fluid milk. Cows are kept in free-stall barns and never graze in an open pasture. While this system does produce the most milk per cow, it also requires considerable investment in animal housing and it has the highest culling rate (30-50 percent) for cows (Lacy, et al.). The result is that the conventional system requires substantial levels of operating and fixed capital. In addition to the cost concerns, because of the high culling rate and perceived environmental issues from these animal feedlots, many consumers are expressing preference for milk produced using more humane and environmentally-friendly methods.

The first alternative system is generally known as the New Zealand (NZ) style system. This production method relies very heavily on Management Intensive Grazing (MIG) between a summer and winter pasture, minimal supplemental feed, and cross-bred cows. Cows graze 100 percent of the days they are lactating (around 305). The NZ approach also utilizes fewer facilities and equipment than the conventional dairy unit. As a result, input costs are reported to be considerably lower than those in the conventional system. The downside to this method is much lower milk production, in some cases one-half that of the conventional system. Proponents of this system contend that even with the lower milk production, their costs of milk production per hundred pounds produced are lower than conventional producers with the higher investment costs, and culling rates.

The second alternative is a hybrid (HY) system that combines the positive aspects of the NZ system but with higher levels of supplementation depending on forage availability and quality. Cows in the HY system will still graze close to 100 percent of their lactating days but have will also have more supplementation than in the grazing system. The result is a production regimen that falls between the conventional and NZ system both in terms of milk production and cost.

Objectives

This paper examines the economic costs and returns for each of the three systems using a budget containing variable costs, detailed feed rations and milk production. Specifically the paper presents the income over feed costs, returns over variable costs revenues for each of the three systems. This paper aims to determine if the HY or NZ systems are viable production and business models for Southeastern dairy producers.

Literature Review

Several studies have evaluated the economics of different production systems and/or herd sizes but none have been specific to the Southeastern U.S. These studies focus on the Northeastern U.S., which has a different climate and market structure, and were published prior to increased milk price volatility and high feed prices starting in 2006 (Dartt, et al., 1999; Parker, et al., 1992; Tozer, et al., 2003; White, et al., 2002). Most comparison studies demonstrate that milk production per cow on a pasture-based system is lower than with a confinement system (Kolver and Muller, 1998; Bargo et al., 2002; White et al., 2002). With higher milk prices, the profitability of confinement rises faster than the NZ and HY models and the opposite is also true, with lower milk prices, the profitability decreases faster with the CONV system (Tozer, et al. 2003). The results in Tozer, et al., (2003) however, seem to counter findings by Soriano et al. (2001), Tucker et al. (2001) and White et al. (2002) which demonstrated that NZ systems yielded higher economic returns than traditional confinement systems.

Methods

Simulated costs and returns for Georgia and surrounding Southeastern U.S. states were estimated for the three different dairy production systems. This analysis assumes all systems are already operating at normal capacity. Returns were estimated using producer-provided production estimates and historical milk prices (Federal Marketing Orders 7&8) from 2008-2012. Adjustments for culling rates were made among the three systems. The following culling rates were used: 32 percent for the CONV; 28 percent for the HY; and 25 percent for the NZ system; cull cows were sold at a price of $650 for the CONV and HY systems and $560 for the NZ system. The model assumes a larger-framed cow in the CONV system, a smaller-framed cow for the NZ system and a medium-framed and/or hybrid for the HY system. The lower cull sales price in the NZ model reflects the smaller-framed animal. The CONV system was based on 1000 head, 454 bred heifers, and 429 young heifers. The NZ system included 600 head, 250 bred heifers, and 250 young heifers. The HY system was based on 600 head, 257 bred heifers, and 257 young heifers. Expected rolling herd averages ranged from 22,000-26,000 lbs for the CONV system; 13,500-16,500 lb for the NZ; and 17,000-21,000 pounds for the HY. The rolling herd averages for each system were used as the expected production for each cow.

All costs and production are based on an annual basis. Variable cost estimates were obtained from current published university extension budgets, producer interviews, and publicly available bench-marking data. Specific forage systems and estimated costs for the pasture-based systems were developed based on interviews with university forage and dairy production specialists as well as dairy producers currently utilizing these production technologies. Table 2 details the feed rations for the lactating cows within the three systems. The payroll for each of the systems was also included in the variable costs. The CONV system had the highest payroll at $728,000, followed by the HY system at nearly $407,000. The NZ system, not needing as many personnel for feeding and machinery operations, incurred $150,000 in payroll.

Given the uncertainty and risk associated with dairy production, a Monte Carlo approach was utilized. Using the Monte Carlo approach, stochastic variables that affect the return and overall output are assigned probability distributions so that random values are drawn repeatedly from these distributions during the simulations to accurately reflect all possible combinations of the variables. (Yeboah, et al., 2013). The model used a Monte Carlo simulation with stochastic variables simulated using @Risk (Palisade Corporation). The stochastic variables include milk production, Southeastern milk prices, and prices for soybean meal, soybean hulls, corn gluten feed, ground corn and citrus pulp. The Akaike Information Criterion (AIC) was used to determine the appropriate distribution for the stochastic variables. The triangular distribution was set for the feed prices; a uniform distribution for the milk production; and a normal distribution for the milk prices. Correlation analysis was conducted for the stochastic input and output variables and the appropriate correlations were set within the model (Table 1). Monthly prices from March 2008 through December 2012 were used to correlate Southeast milk prices, soybean meal, soybean hulls, corn gluten and corn. Due to lack of price data, citrus pulp was correlated to the other variables based on yearly values from 2008-2012. It is important to note that soybean hulls, corn gluten and corn are relatively correlated (>0.60) to Southeast milk prices. Due to the high use of feed inputs in the confinement system, changes in the input prices can dramatically sway the profitability of the system.

Using the stochastic variables and detailed budgets of estimated costs for the three systems, the model calculated the total revenues, income over feed costs, returns over variable costs and breakeven price for variable costs with n=500 iterations.

Results

Within the three models, revenues were based on milk production, butterfat premium, the sale of bull calves, and cull cow and heifers. The price of milk was set at $19.11/cwt as generated from the 2008-2012 monthly averages. Table 3 shows the summary statistics for the simulated feed prices and milk production for the three systems.

Conventional

The CONV model's revenue included 240,000 hundredweight (cwt) of milk production, butterfat premium, 296 cull cows at $650/each and 429 bull calves at $75/each (Table 3). The average revenue for this model is $4,847,272.88. The system is expected to reach this revenue in a little more than 50 percent of the simulations. The lowest expected revenue is $2.3 million while revenues top out at $7.4 million in less than five percent of the simulations. Variable costs ranged from $4.04 to $4.79 million, resulting in returns over variable costs ranging from losing nearly $2 million to gaining $3 million. This system's ROVC is greater than zero in 72.8 percent of the simulations.

With regard to variables costs, corn, corn gluten and citrus pulp have the largest impact on variable cost outputs (Figure 1). The difference between a high and low price of corn is nearly a $800,000 difference in regard to the variable costs mean. Conversely, soybean meal has the smallest effect of the grain inputs with only a $400,000 difference between the highest and lowest price of soybean meal simulated. It is important to note that the conventional system was the only model to be able cover feed costs in 100 percent of the simulations.

Grazing

The NZ model included milk sales of 90,000 cwt, 143 cull cows at $560/each, 250 bull calves at $75/each and 43 excess heifers at $1,600/each (Table 4). The average butterfat was 3.5 percent which is the cutoff for the butterfat premium, hence no premium within this system. The average revenue was $1,878,867.74 with an upper bound at nearly $3 million and a lower bound right at $1 million. Variable costs ranged from $1.4 million to almost $2 million causing the return over variable costs to range from losing $850,000 to a surplus of $1.3 million. Even with possibility of negative ROVC, the system has ROVC greater than zero in 68.4 percent of the simulations. While there is a potential that return over feed cost could be negative, return over feed cost is positive in 99.2 percent of the simulations.

Corn, corn gluten and soybean hull prices had the greatest effect on variable costs within the NZ model (Figure 2). The effect of high versus low corn prices on the HY variable costs is approximately $350,000. Nitrogen fertilizer prices have the smallest effect on variable costs, only swaying the output mean by $30,000.

Hybrid

The HY model generated 114,000 cwt of milk, butterfat premium, 198 cull cows at $650/each, 13 excess heifers at $1,600/each, and 257 bull calves at $75/each (Table 5). The average revenue was nearly $2.4 million with a range of nearly $1.3million to $3.6 million. Variable costs ranged from $2.1 million to $2.5 million with a mean of $2.3 million. The return over variable costs is positive in 55.4 percent of the simulations.

While the returns over feed cost has a negative lower bound, return over feed costs is greater than zero in 99.4 percent of the simulations.

Similar to the NZ model, change in corn, corn gluten and soybean hull prices have the largest effect on the mean of variable costs. The effect in high corn prices versus low corn prices is approximately $250,000, less than that of the CONV system. The input with the least effect on variable costs is potash, where the effect of the highest and lowest prices is only $27,000.

Conclusion

As discussed the conventional system has by far the highest revenues but also has the highest variable and fixed costs. Even with moderate milk production, the NZ and HY models are viable and profitable alternatives but the ultimate profitability depends on feed and milk prices. When feed prices are low and milk prices are high, the CONV system is more profitable. Alternatively, when feed prices are high and milk is moderately priced, the NZ and HY systems are more profitable. Although net returns are lower in the NZ and HY models, the standard deviation per cow is also smaller and includes less variability in the output values. Fixed costs are an integral part of the budgeting process and will be further evaluated in future papers. At the time of submission, adequate information on fixed costs was not available. However, given that both of these models generate positive ROVC, it reasonable to conclude that they are viable production alternatives for producers in the Southeastern U.S. While this analysis assumes a start-up operation, further analysis is needed to determine the feasibility of current operating farms transitioning from a CONV system to a NZ or HY-based production system.

Table 1: @Risk Correlations used in the confinement, HY and grazing models.

@RISK Correlations	Soybean Hulls	Corn Gluten	Corn	Soybean Meal	Citrus Pulp	SE Milk Price
Soybean Hulls	1					
Corn Gluten	0.935797751	1				
Corn	0.792433268	0.864463464	1			
Soybean Meal	0.408453307	0.545086534	0.537507564	1		
Citrus Pulp	0.672925433	0.650269086	0.62064209	0.527693342	1	
SE Milk Price	0.670588614	0.644640067	0.747062954	0.112280756	0.141283437	1

Table 2: Lactating rations for the confinement, grazing and hybrid systems

Ingredient	%DM	$/ton	$/lb	Confinement lb AF /d	$/d	Pasture 1 lb AF /d	$/d	Pasture 2 lb AF /d	$/d	Hybrid lb AF /d	$/d
Pasture	25.0	25	0.013			75.600	0.945	64.000	0.8	30.000	0.375
Corn silage, processed	35.0	65	0.033	62.857	2.043			14.286	0.464	45.714	1.486
Winter annual silage	32.4	50	0.025	15.432	0.386					10.802	0.270
Brewers grains, wet	24.5	39	0.020	26.531	0.517					20.408	0.398
Ground corn	88.0	349	0.175	9.091	1.586	14.205	2.478	12.500	2.181	7.955	1.388
Soybean hulls	91.0	191	0.096			1.868	0.178	1.868	0.178		
Citrus pulp	88.6	195	0.098	4.515	0.440	3.950	0.385	3.950	0.385	3.386	0.330
Soybean meal, 47% CP	90.0	394	0.197	4.444	0.875	1.111	0.219	1.111	0.219	2.222	0.438
Corn gluten feed	89.7	206	0.103			3.344	0.344	2.676	0.276		
Urea	99.0	597	0.299	0.152	0.045	0.101	0.030	0.101	0.030	0.131	0.039
Amino Plus	88.0	560	0.280	2.102	0.589					1.705	0.477
Calcium carbonate	99.5	154	0.077	0.553	0.043	0.503	0.039	0.503	0.039	0.503	0.039
Calcium Phospahte mono	99.5	781	0.391	0.101	0.039					0.101	0.039
Magensium oxide	99.5	589	0.295	0.101	0.030	0.075	0.022	0.075	0.022	0.075	0.022
Salt	99.5	225	0.113	0.151	0.017	0.101	0.011	0.101	0.011	0.113	0.013
Potassium carbonate	99.5	1770	0.885	0.101	0.089					0.113	0.100
Sodium bicarbonate	99.5	451	0.226	0.402	0.091	0.301	0.068	0.301	0.068	0.301	0.068
Potassium magnesium sulfate	99.5	623	0.312	0.151	0.047	0.101	0.031	0.101	0.031	0.113	
Yeast culture	93.0	1800	0.900	0.134	0.121					0.134	0.121
Supplemental Cu, Mn, Co, Zn	93.1	3998	1.999	0.021	0.042					0.021	0.042
Trace mineral	99.50	1895	0.948	0.013	0.012	0.017	0.016	0.017	0.016	0.013	0.012

Table 3: @Risk summary statistics for stochastic feed variables and milk production

Name	Soybean Hulls/ton	Corn Gluten/ton	Corn/ bushel	Soybean Meal/ton	Citrus Pulp/ton	Milk/lbs	CONV MilkProd	NZ Milk Prod	HY Milk Prod
Min	104.4332	122.5428	4.048188	267.5269	104.0706	9.260475	22003.71	17006.91	17005.96
Max	293.5244	310.6356	8.323396	554.938	290.9596	29.74645	25995.71	20999.34	20995.93
Mean	191.3175	205.7352	6.224987	394.0823	194.7242	19.1111	23999.94	19000.23	18999.74
Std Dev	40.70673	40.68287	0.9156759	62.95865	39.8942	3.220951	1155.624	1155.924	1155.897
Variance	1657.038	1655.095	0.8384624	3963.792	1591.547	10.37452	1335467	1336161	1336098
5% Perc	127.2693	144.3838	4.675895	300.4759	128.99	13.77912	22198.73	17192.3	17193.51
25% Perc	161.349	175.0437	5.567977	345.9297	165.8802	16.92964	22997.48	17994.85	17993.34
50% Perc	188.156	201.316	6.233302	386.2953	193.3296	19.09534	23996.02	18998.88	18996.03
75% Perc	219.9712	234.1969	6.878253	438.1513	223.0389	21.26692	24994.06	19992.45	19993.15
95% Perc	262.7127	278.4315	7.746723	507.0255	262.6203	24.37026	25792.57	20793.29	20798.1

Table 4: Simulated summary statistics generated by @Risk for the conventional budget

Name	Revenues	Revenues / Per Cow	Variable Costs	Variable Costs / Per Cow	ROVC	ROVC / Per Cow	RO Feed Cost	RO Feed Cost / Per Cow
Minimum	$2,388,431.28	$2,388.43	$4,041,749.25	$4,041.75	($1,814,697.46)	($1,814.70)	$1,739,762.65	$1,739.76
Maximum	$7,433,245.23	$7,433.25	$4,779,289.48	$4,779.29	$3,233,007.18	$3,233.01	$6,800,539.81	$6,800.54
Mean	$4,847,272.88	$4,847.27	$4,372,878.60	$4,372.88	$474,394.28	$474.39	$4,177,732.36	$4,177.73
Std Deviation	$806,108.04	$806.11	$147,683.57	$147.68	$812,499.07	$812.50	$806,164.37	$806.16
Variance	6.4981E+11	649810.2	21810440000	21810.44	6.60155E+11	660154.8	6.49901E+11	649901
5% Perc	$3,551,289.20	$3,551.29	$4,136,151.09	$4,136.15	($859,823.24)	($859.82)	$2,889,631.17	$2,889.63
25% Perc	$4,280,867.31	$4,280.87	$4,259,158.70	$4,259.16	($92,072.62)	($92.07)	$3,581,935.16	$3,581.94
50% Perc	$4,837,949.02	$4,837.95	$4,366,807.52	$4,366.81	$460,799.66	$460.80	$4,173,150.83	$4,173.15
75% Perc	$5,406,376.31	$5,406.38	$4,480,055.05	$4,480.06	$993,821.32	$993.82	$4,719,268.98	$4,719.27
95% Perc	$6,191,930.71	$6,191.93	$4,615,521.61	$4,615.52	$1,835,506.59	$1,835.51	$5,536,225.84	$5,536.23

Table 5: @Risk simulated summary statistics for the grazing model

Name	Revenues	Revenues / per cow	Variable Costs	Variable Costs / per cow	ROVC	ROVC / per cow	RO Feed Cost	RO Feed Cost / per cow
Minimum	$997,252.20	$1,662.09	$1,445,840.13	$2,409.73	($760,024.24)	($1,266.71)	($173,442.22)	($289.07)
Maximum	$2,878,085.33	$4,796.81	$2,002,070.61	$3,336.78	$1,244,892.78	$2,074.82	$1,838,108.29	$3,063.51
Mean	$1,878,867.74	$3,131.45	$1,726,823.53	$2,878.04	$152,044.21	$253.41	$737,848.47	$1,229.75
Std Deviation	$312,898.17	$521.50	$114,226.53	$190.38	$338,267.72	$563.78	$341,428.28	$569.05
Variance	97905260000	271959.1	13047700000	36243.61	1.14425E+11	317847.3	1.16573E+11	323814.6
5% Perc	$1,385,016.12	$2,308.36	$1,540,874.01	$2,568.12	($395,121.13)	($658.54)	$182,138.36	$303.56
25% Perc	$1,662,197.26	$2,770.33	$1,639,546.64	$2,732.58	($82,052.05)	($136.75)	$499,921.73	$833.20
50% Perc	$1,874,522.42	$3,124.20	$1,725,603.19	$2,876.01	$133,294.45	$222.16	$720,247.25	$1,200.41
75% Perc	$2,079,282.62	$3,465.47	$1,806,077.64	$3,010.13	$364,395.48	$607.33	$958,116.85	$1,596.86
95% Perc	$2,361,743.14	$3,936.24	$1,921,807.08	$3,203.01	$711,214.03	$1,185.36	$1,304,406.57	$2,174.01

Table 6: @Risk simulated summary statistics for the hybrid model

Name	Revenues / total	Revenues / per cow	Variable Costs / total	Variable Costs / per cow	ROVC / total	ROVC / per cow	RO Feed Cost / total	RO Feed Cost / per cow
Minimum	$1,292,272.39	$2,153.79	$2,126,524.12	$3,544.21	$(1,058,552.36)	$(1,764.25)	$(129,755.17)	$(216.26)
Maximum	$3,603,438.03	$6,005.73	$2,531,276.66	$4,218.79	$1,296,693.03	$2,161.16	$2,243,556.21	$3,739.26
Mean	$2,392,451.84	$3,987.42	$2,326,571.78	$3,877.62	$65,880.07	$109.80	$999,945.61	$1,666.58
Std Deviation	$387,772.66	$646.29	$77,718.73	$129.53	$392,979.36	$654.97	$395,623.15	$659.37
Variance	1.50368E+11	417687.9	6040202000	16778.34	1.54433E+11	428979.9	1.56518E+11	434771.3
5% Perc	$1,763,128.51	$2,938.55	$2,194,998.01	$3,658.33	$(609,214.14)	$(1,015.36)	$318,108.64	$530.18
25% Perc	$2,114,404.14	$3,524.01	$2,271,458.99	$3,785.76	$(199,196.01)	$(331.99)	$733,887.14	$1,223.15
50% Perc	$2,384,803.14	$3,974.67	$2,327,230.99	$3,878.72	$63,936.39	$106.56	$995,610.15	$1,659.35
75% Perc	$2,659,567.13	$4,432.61	$2,379,013.24	$3,965.02	$337,539.30	$562.57	$1,275,250.52	$2,125.42
95% Perc	$3,040,754.25	$5,067.92	$2,457,355.97	$4,095.59	$744,800.37	$1,241.33	$1,679,685.53	$2,799.48

Figure 1: @Risk generated variable input costs ranked by effect on output mean for the conventional model

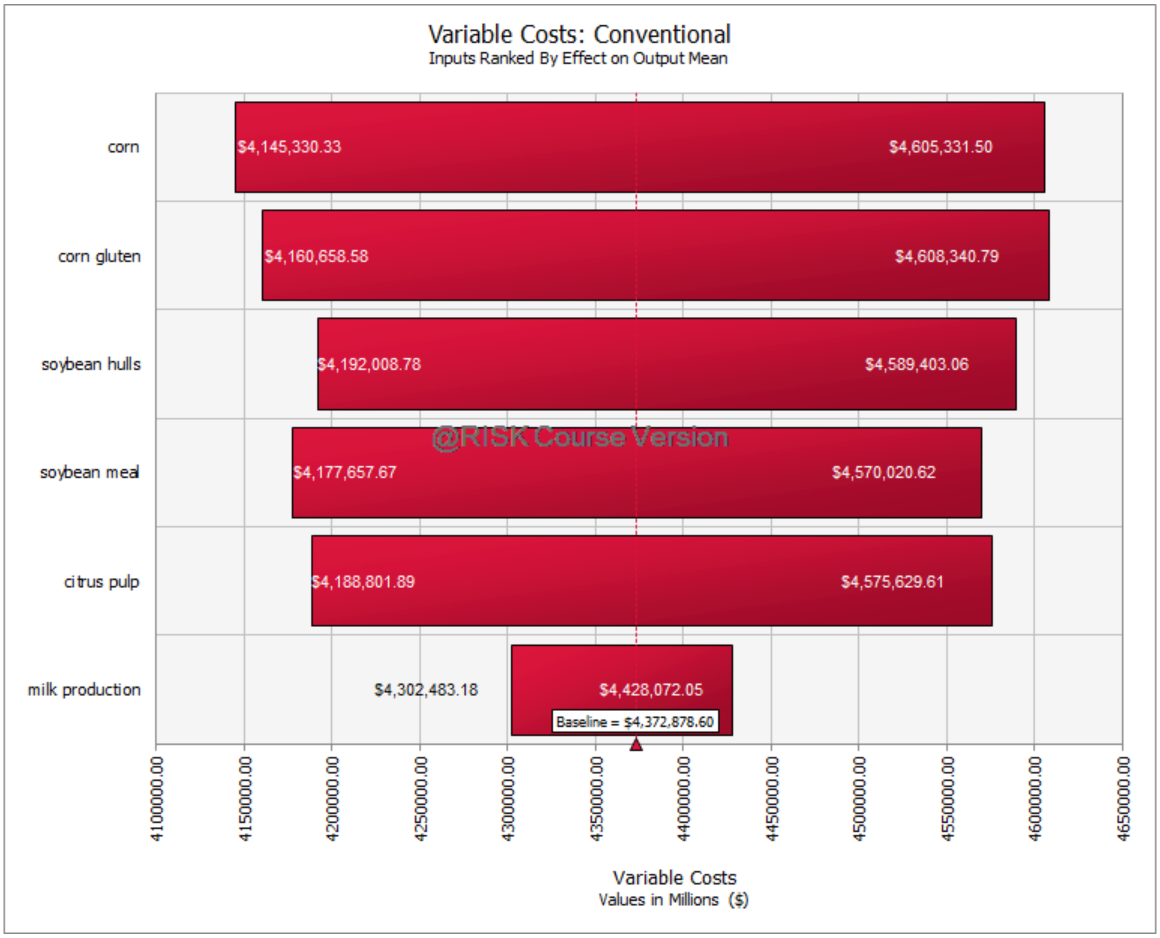


Figure 2: @Risk generated variable input costs ranked by effect on output mean for the grazing model

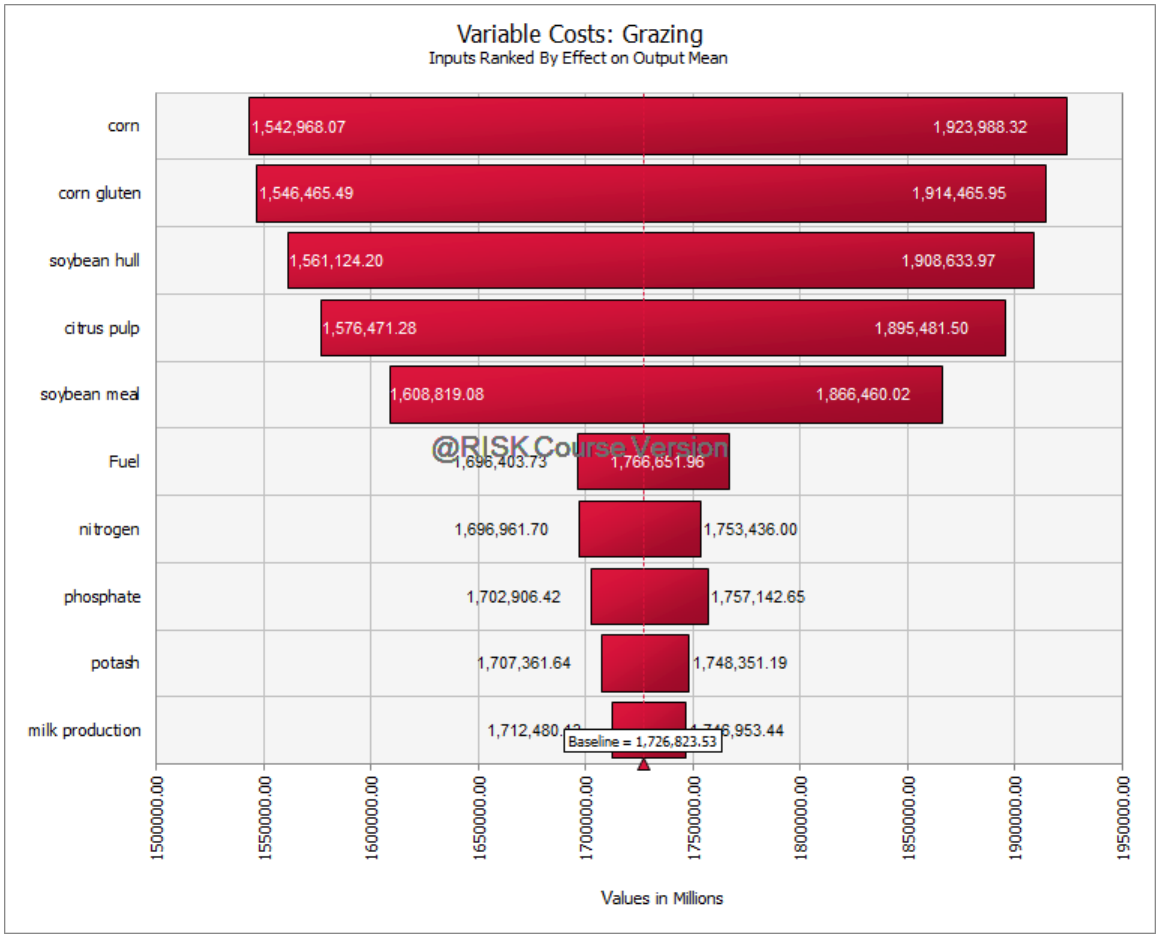
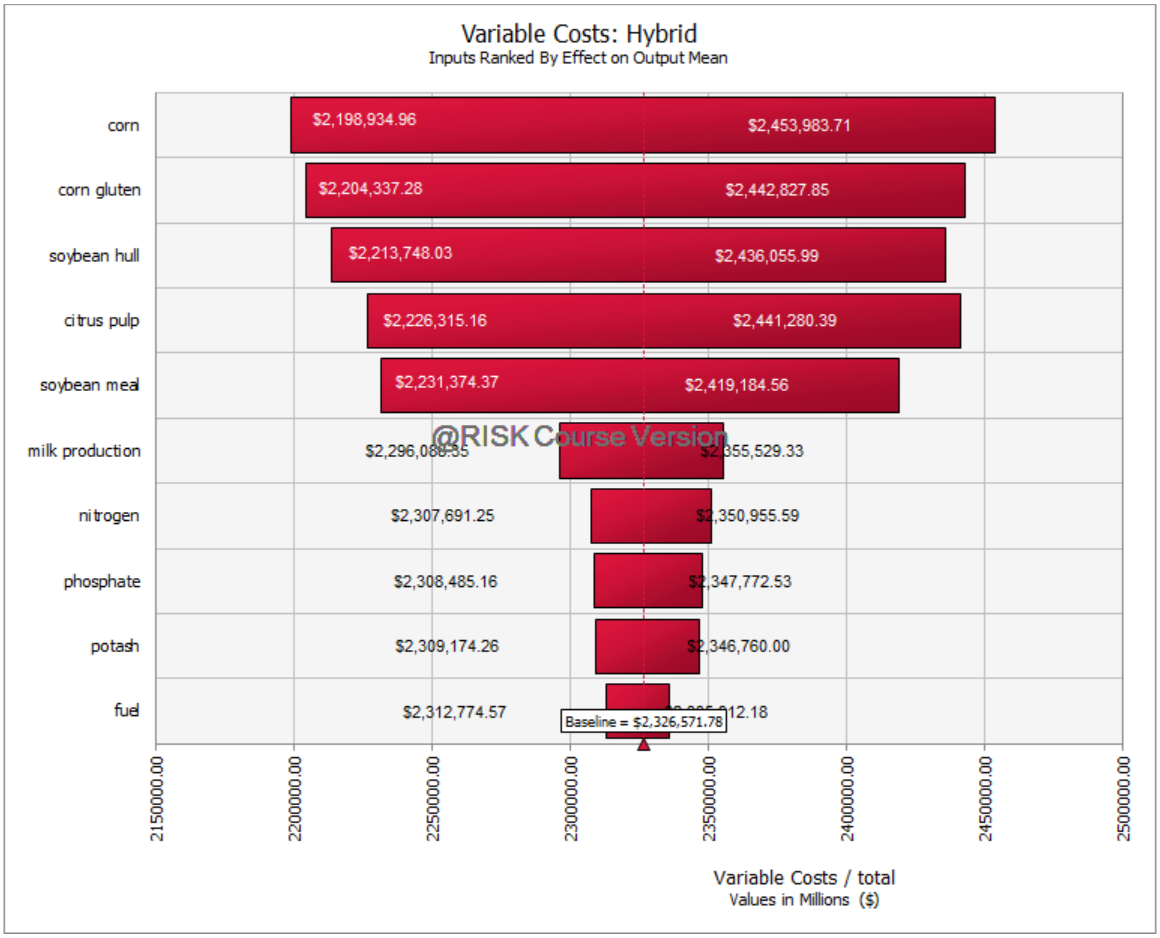


Figure 3: @Risk generated variable input costs ranked by effect on output mean for the hybrid model



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