

Stochastic Programming Workbook

2-Bin Method

SPW2

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Tutorial

This PDF file shows you how to use SPW2.xls Workbook to calculate the costs of providing CP at any probability levels for feeds formulated by the 2-Bin Method

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1		Low Corn	High Corn	Low SBM	High SBM	Poultry Fat	Limestone	DCP	Vitamin premix	Mineral premix	salt	DL-Met	MIN (Nutrient)	MAX (Nutrient)	Supplied	Average content
2	Cost (\$)	6.00	15.00	28.00	25.00	34.00	3.00	21.00	370.00	57.00	2.78	230.00				
3	weight	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	CP	6.40	7.29	46.41	45.36	0.00	0.00	0.00	1.00	0.00	0.00	67.52	23.00	0.00	23.00	23.24
5	CP SD	0.26	0.27	0.85	0.86	0.00	0.00	0.00	1.00	0.00	0.00	1.00			0.53	0.53
6	Corn CP	1.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
7	Low Corn	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.24	0.00
8	High Corn	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.24	0.00
9	SBM CP	0.00	0.00	1.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
10	High SBM	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.21	0.00
11	Low SBM	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.21	0.00
12	ME	0.25	0.25	2.44	2.44	8.20	0.00	0.00	1.00	0.00	0.00	3.60	3.20	0.00	3.20	3.20
13	Ca	0.02	0.02	0.27	0.27	0.00	38.00	21.90	1.00	0.00	0.30	1.00	1.00	0.00	1.00	1.00
14	NPP	0.00	0.00	0.40	0.40	0.00	0.00	18.70	1.00	0.00	0.00	1.00	0.45	0.00	0.45	0.45
15	ISAA	0.29	0.29	1.28	1.28	0.00	0.00	0.00	1.00	0.00	0.00	58.00	0.90	0.00	0.90	0.90
16	Met	0.14	0.14	0.62	0.62	0.00	0.00	0.00	1.00	0.00	0.00	58.00	0.90	0.00	0.53	0.56
17	Cysteine	0.05	0.05	0.65	0.65	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.34	0.34
18	Lysine	0.20	0.20	2.83	2.88	0.00	0.00	0.00	1.00	0.00	0.00	1.00	1.00	0.00	1.20	1.20
19	Arginine	0.32	0.32	3.40	3.40	0.00	0.00	0.00	1.00	0.00	0.00	1.00	1.25	0.00	1.57	1.57
20	Valine	0.32	0.32	2.25	2.25	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.90	0.00	1.09	1.09
21	Tryptophan	0.06	0.06	0.64	0.64	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.20	0.00	0.29	0.29
22	phenylalanine	0.23	0.23	2.40	2.40	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.72	0.00	1.16	1.16
23	Threonine	0.24	0.24	1.89	1.90	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.80	0.00	0.83	0.88
24	Isoleucine	0.23	0.23	2.14	2.14	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.80	0.00	1.00	1.00
25	Histidine	0.19	0.19	1.19	1.19	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.36	0.00	0.53	0.59
26	sigma ² Xj ²	0.01	0.01	0.03	0.03	0.00	0.00	0.00	1.00	0.00	0.00	1.00				
27	Quantities	0.24	0.24	0.21	0.21	0.07	0.02	0.01	1.00	0.00	0.00	1.00				
28	MIN (Ingredient)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00				
29	MAX (Ingredient)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00				
30	Cost Ingredient	0.76	0.76	5.85	5.85	2.47	0.08	0.24	1.33	0.05	0.01	0.52				
31	Formula cost \$	0.336														
32	Z-value	0.01														
33	Probability	0.80														

SPW2.xls Workbook Tool Overview

CP mean & standard deviation for each ingredient

The minimum specifications & and the maximum levels of nutrients

The supplied amount of each nutrient in the final formula P=0.5

The average nutrient content at the specified probability level

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
	Low Corn	High Corn	Low SBM	High SBM	Poultry Fat	Limestone	DCP	Vitamin premix	Mineral premix	salt	DL-Met	MW (Nutrient)	MAX (Nutrient)	Supplied	Average content	
2	Cost (\$)	6.00	15.00	28.00	25.00	34.00	3.00	25.00	370.00	57.00	2.78	230.00				
3	Weight	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	CP	6.40	7.39	46.41	43.56	0.00	0.00	0.00	1.00	0.00	0.00	57.52	20.00	100	23.00	25.24
5	CP SD	0.56	0.37	0.85	0.86	0.00	0.00	0.00	1.00	0.00	0.00	1.00			0.53	0.53
6	Corn CP	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	Low Corn	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00
8	High Corn	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00
9	SBM CP	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	High SBM	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00
11	Low SBM	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00
12	ME	3.35	3.35	2.44	2.44	8.25					3.67	3.20	100	3.20	3.20	3.20
13	Ca	0.02	0.02	0.27	0.27	0.00	38.00	21.00	1.00	0.00	0.20	1.00	1.00	1.00	1.00	1.00
14	NPP	0.10	0.10	0.40	0.40	0.00	0.00	18.70	1.00	0.00	0.00	1.00	0.45	1.00	0.45	0.45
15	TSAA	0.29	0.29	1.28	1.28	0.00	0.00	0.00	1.00	0.00	0.00	58.00	0.90	1.00	0.90	0.90
16	Met	0.14	0.14	0.62	0.62	0.00	0.00	0.00	1.00	0.00	0.00	58.00	0.90	1.00	0.55	0.56
17	Cysteine	0.15	0.15	0.65	0.65	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	0.34	0.34
18	Lysine	0.20	0.20	2.83	2.88	0.00	0.00	0.00	1.00	0.00	0.00	1.00	1.00	1.00	1.20	1.20
19	Arginine	0.32	0.32	3.40	3.40	0.00	0.00	0.00	1.00	0.00	0.00	1.00	1.25	1.00	1.57	1.57
20	Valine	0.32	0.32	2.25	2.25	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.90	1.00	1.09	1.09
21	Tryptophan	0.06	0.06	0.64	0.64	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.20	1.00	0.29	0.29
22	phenylalanine	0.33	0.33	2.40	2.40	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.72	1.00	1.16	1.16
23	Threonine	0.24	0.24	1.83	1.83	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.80	1.00	0.83	0.88
24	Isoleucine	0.23	0.23	2.14	2.14	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.80	1.00	1.00	1.00
25	Histidine	0.19	0.19	1.18	1.18	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.35	1.00	0.53	0.59
26	sigma ² (A) ²	0.01	0.01	0.03	0.03	0.00	0.00	0.00	1.00	0.00	0.00	1.00				
27	Quantities	0.24	0.24	0.21	0.21	0.07	0.02	0.01	1.00	0.00	0.00	1.00				
28	MIN (ingredient)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00				
29	MAX (ingredient)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00				
30	Corn ingredient	0.70	0.70	0.65	0.65	2.17	0.00	0.24	0.33	0.00	0.00	1.00				
31	Formula cost \$	23.82														
32	Z value	-0.01														
33	Probability	0.50														

The low CP and high CP portions are specified in 1:1 ratios to formulate feed with equal proportions

The minimum & maximum levels for each ingredient in the final formula

The desired probability of success to meet the specified protein level in feed

SPW2.xls Workbook Tool Overview

Formula Cost = \$23.52

The amount of each ingredient used

The supplied levels of nutrients

Ingredient	Cost \$/cwt	Min. %	Amount %	Max. %
Low Corn	16.00	0.00	23.52	00.00
High Corn	16.00	0.00	23.52	00.00
Low SBM	28.00	0.00	20.89	00.00
High SBM	28.00	0.00	20.89	00.00
Poultry fat	34.00	0.00	7.27	00.00
Limestone	370.00	0.00	1.64	00.00
DCP	20.00	0.00	1.19	00.00
Vitamin premix	370.00	0.25	0.25	0.25
Mineral premix	67.00	0.15	0.15	0.15
salt	2.76	0.45	0.45	00.00
DL-Met	220.00	0.00	0.24	00.00
Total			100.00	

Nutrient	Required	Supplied	Max.	Units
ME	3.20	3.20	100.00	Mcal
CP	23.00	23.00	100.00	%
Ca	1.00	1.00	100.00	%
NPP	0.45	0.45	100.00	%
TSAA	0.90	0.90	100.00	%
Lysine	1.10	1.30	100.00	%
Threonine	0.80	0.88	100.00	%
Met	0.50	0.56	100.00	%
Cysteine	0.00	0.34	100.00	%
Arginine	1.25	1.57	100.00	%
Valine	0.90	1.09	100.00	%
phenylalanine	0.72	1.16	100.00	%
Tryptophan	0.20	0.29	100.00	%
Isoleucine	0.80	1.00	100.00	%
Histidine	0.35	0.59	100.00	%

Title: Stochastic Outputs

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
	Low Corn	High Corn	Low SBM	High SBM	Poultry fat	Limestone	DCP	Vitamin premix	Mineral premix	salt	DL-Met	MIN (Nutrient)	MAX (Nutrient)	Supplied	Average content	
2	Cost (\$)	6.00	15.00	28.00	21.00	34.00	3.00	21.00	370.00	57.00	2.78	230.00				
3	weight	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	CP	8.40	7.39	46.41	41.56	0.00	0.00	0.00	0.00	0.00	87.92	23.00	0.00	33.00	25.24	
5	CP SD	0.56	0.37	0.85	0.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.53	
6	Corn CP	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
7	Low Corn	1.00	0.00											0.00	0.24	0.00
8	High Corn	0.00	1.00											0.00	0.24	0.00
9	SBM CP	0.00	0.00											0.00	0.00	0.00
10	High SBM	0.00	0.00											0.00	0.21	0.00
11	Low SBM	0.00	0.00											0.00	0.21	0.00
12	ME	3.35	3.35											0.00	3.20	3.20
13	Ca	0.02	0.02											0.00	1.00	1.00
14	NPP	0.00	0.00											0.00	0.45	0.45
15	ISAA	0.29	0.29											0.00	0.90	0.90
16	Met	0.14	0.14											0.00	0.55	0.56
17	Cysteine	0.05	0.05											0.00	0.34	0.34
18	Lysine	0.20	0.20											0.00	1.20	1.20
19	Arginine	0.32	0.32											0.00	1.57	1.57
20	Valine	0.32	0.32											0.00	1.09	1.09
21	Tryptophan	0.06	0.06											0.00	0.29	0.29
22	phenylalanine	0.33	0.33	2.40	2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.16	1.16
23	Threonine	0.24	0.24	1.83	1.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.83	0.88
24	Isoleucine	0.23	0.23	2.40	2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00
25	Histidine	0.18	0.18	1.18	1.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.59
26	$\sigma_{ij} = 2^i X_j^2$	0.01	0.01	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
27	Quantities	0.24	0.24	0.21	0.21	0.07	0.06	0.01	0.00	0.00	0.00	0.00	0.00			
28	MIN (Ingredient)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
29	MAX (Ingredient)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
30	Cost Ingredient	3.76	3.76	5.85	5.85	2.47	0.00	0.24	0.33	0.00	0.00	0.00	0.00			
31	Formula cost \$	23.52														
32	L value	-0.01														
33	Probability	0.80														

Using the current settings (ingredients composition matrix, minimum specifications, CP statistics... etc.) the workbook can be used as following:

Optimizing the Stochastic Feed Formulation Problem

The image shows a Microsoft Excel spreadsheet with the Solver Parameters dialog box open. The spreadsheet contains a table with columns for 'Low Corn', 'High Corn', 'Low SDM', and 'High SDM'. The Solver Parameters dialog box is configured with the following settings:

- Set Objective:** \$B\$31
- To:** Max, Min, Value Of: 0
- By Changing Variable Cells:** \$B\$27:\$D\$27
- Subject to the Constraints:**
 - \$C\$9 <= \$N\$9
 - \$C\$8 >= \$M\$8
 - \$C\$8 <= \$N\$8
 - \$C\$7 >= \$M\$7
 - \$B\$27:\$D\$27 >= 0
 - \$C\$7 >= \$M\$7
 - \$C\$6 <= \$N\$6
 - \$C\$7 <= \$N\$7
 - \$C\$5 >= \$M\$5
 - \$C\$6 >= \$M\$6
 - \$C\$5 >= \$M\$5
 - \$C\$3 <= \$N\$3
 - \$C\$27 <= \$C\$29
- Make Unconstrained Variables Non-Negative
- Select a Solving Method:** GRG Nonlinear engine
- Solving Method:** Select the GRG Nonlinear engine for Solver Problems that are smooth nonlinear. Select the LP Simplex engine for linear Solver Problems, and select the Evolutionary engine for Solver problems that are non-smooth.

Annotations in red boxes provide instructions:

- (1) Select the desired probability of success (between 0 & 1)**: Points to the 'Probability' cell in the spreadsheet.
- (2) Select the solver option**: Points to the 'Solver' button in the top right corner of the Excel ribbon.
- (3) Click solve**: Points to the 'Solve' button in the Solver Parameters dialog box.

	Low Corn	High Corn	Low SDM	High SDM	Probability
Cost (\$)	6.00	6.00	30.00	30.00	
Weight	1.00	1.00	1.00	1.00	
CP	64.1	7.39	45.41	48.61	
CP SD	1.24	1.24	0.26	0.26	
Corn CP	1.00	1.00	0.00	0.00	
Low Corn	1.00	0.00	0.00	0.00	
High Corn	0.00	1.00	0.00	0.00	
SBM CP	0.00	0.00	0.00	0.00	
High SBM	0.00	0.00	0.00	0.00	
Low SBM	0.00	0.00	1.00	0.00	
ME					
Ca					
NPP					
TSAA					
Met					
Cysteine					
Lysine					
Arginine					
Valine					
Tryptophan					
phenylal					
Threonine	0.24	0.24	1.00	0.00	
Isoleucine	0.23	0.23	0.26	0.26	
Histidine	0.19	0.19	1.1E-05	1.1E-05	
sigma-1*%2	0.00	0.00	0.26	0.26	
Quantities	0.24	0.24	0.26	0.26	
MIN (Ingredient)	0.00	0.00	0.00	0.00	
MAX (Ingredient)	1.00	1.00	1.00	1.00	
Cost Ingredient	6.00	6.00	30.00	30.00	
Formulation \$	6.00	6.00	30.00	30.00	
Value	0.00	0.00	0.00	0.00	
Probability	0.70	0.70	0.70	0.70	

Optimizing the Stochastic Feed Formulation Problem

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1		Low Corn	High Corn	Low SBM	High SBM	Poultry fat	Limestone	DCP	Vitamin premix	Mineral premix	salt	DL-Met	MIN [Nutrient]	MAX [Nutrient]	Supplied	Average content
2	Cost (\$)	15.0	16.0	23.0	26.0	34.0	3.0	30.0	370.0	57.0	2.78	250.0				
3	weight	10	10	100	10	10	10	10	10	10	10	100	100	100	10	100
4	CP	6.40	7.33	46.4	46.63	0.00	0.0	0.00	0.00	0.00	0.0	27.52	23.0	10	23.00	23.15
5	CP:SD	0.36	0.37	1.25	0.81	0.00	0.0	0.00	0.00	0.00	0.0	1.0			0.53	1.23
6	Corn CP	-1.00	1.0	1.0	0.0	0.00	0.0	0.00	0.00	0.00	0.0	1.0	0.0	0	0.0	1.0
7	Low Corn	10	0.0	1.0	0.0	0.00	0.0	0.00	0.00	0.00	0.0	1.0	0.0	0	0.24	1.0
8	High Corn	0.00	1.0	1.0	0.0	0.00	0.0	0.00	0.00	0.00	0.0	1.0	0.0	0	0.24	1.0
9	SBM CP	0.00	0.0	-1.0	1.0	0.00	0.0	0.00	0.00	0.00	0.0	1.0	0.0	0	0.0	1.0
10	High SBM	0.00	0.0	1.0	1.0	0.00	0.0	0.00	0.00	0.00	0.0	1.0	0.0	0	0.24	1.0
11	Low SBM	0.00	0.0	1.0	0.0	0.00	0.0	0.00	0.00	0.00	0.0	1.0	0.0	0	0.24	1.0
12	ME	3.35	3.25	2.44	2.44	8.20	0.0	0.00	0.00	0.00	0.0					1.0
13	Ca	0.02	0.02	1.27	0.27	0.00	35.00	2.30	0.00	0.00	0.0					1.0
14	NPP	1.1	0.3	1.40	0.4	0.00	0.0	15.70	0.00	0.00	0.0					1.5
15	TSAA	0.29	0.29	1.28	1.28	0.00	0.0	0.00	0.00	0.00	0.0					1.58
16	Met	1.14	0.4	1.22	0.62	0.00	0.0	0.00	0.00	0.00	0.0					1.34
17	Cysteine	1.1	0.5	1.25	0.65	0.00	0.0	0.00	0.00	0.00	0.0					1.28
18	Lysine	0.20	0.20	1.28	2.8	0.00	0.0	0.00	0.00	0.00	0.0					1.56
19	Arginine	0.32	0.32	1.40	3.4	0.00	0.0	0.00	0.00	0.00	0.0					1.56
20	Valine	0.32	0.32	1.25	2.25	0.00	0.0	0.00	0.00	0.00	0.0		0.0	0	1.9	1.09
21	Tryptophan	0.06	0.05	1.24	0.64	0.00	0.0	0.00	0.00	0.00	0.0		0.0	0	0.29	1.29
22	phenylalanine	0.33	0.33	1.40	2.4	0.00	0.0	0.00	0.00	0.00	0.0		0.0	0	1.5	1.15
23	Threonine	0.24	0.24	1.83	1.83	0.00	0.0	0.00	0.00	0.00	0.0		0.0	0	0.83	1.38
24	Isoleucine	0.23	0.23	2.4	2.4	0.00	0.0	0.00	0.00	0.00	0.0		0.0	0	1.0	1.00
25	Histidine	1.1	0.3	1.1	1.9	0.00	0.0	0.00	0.00	0.00	0.0		0.0	0	0.53	1.29
26	sigma(2+K)-2	1.1	0.1	1.23	0.0	0.00	0.0	0.00	0.00	0.00	0.0					
27	Quantities	0.24	0.24	0.21	0.21	0.07	0.02	1.1	0.30	0.00	0.0					
28	MIN (Ingredient)	0.00	0.0	1.0	0.0	0.00	0.0	0.00	0.00	0.00	0.0					
29	MAX (Ingredient)	10	10	100	10	10	10	10	0.00	0.00	10					
30	Cost (Ingredient)	3.78	3.73	5.22	5.82	2.46	0.0	0.24	0.30	0.0	0.0					

To be 70% sure that the feed contains at least 23% the average content has to be increased to 23.15%

31 Formula cost \$ 23.43
 32 Z value 1.32
 33 Probability 0.70

Optimizing the Stochastic Feed Formulation Problem

Ingredient	Cost \$/cwt	Min. %	Amount %	Max. %
Low Corn	16.00	0.00	23.65	100.00
High Corn	16.00	0.00	23.65	100.00
Low SBM	28.00	0.00	20.77	100.00
High SBM	28.00	0.00	20.77	100.00
Poultry fat	34.00	0.00	7.23	100.00
Limestone	370.00	0.00	1.64	100.00
DCP	20.00	0.00	1.19	100.00
Vitamin premix	370.00	0.25	0.25	0.25
Mineral premix	57.00	0.15	0.15	0.15
salt	2.78	0.45	0.45	100.00
DL-Met	220.00	0.00	0.24	100.00
Total			100.00	

Nutrient	Required	Supplied	Max.	Units
ME	3.20	3.20	100.00	Mcal
Cysteine	0.00	0.34	100.00	%
Arginine	1.25	1.56	100.00	%
Valine	0.90	1.09	100.00	%
phenylalanine	0.72	1.15	100.00	%
Tryptophan	0.20	0.29	100.00	%
isoleucine	0.80	1.00	100.00	%
Histidine	0.35	0.59	100.00	%

Formula Cost = \$23.49

Ingredient usage and formula cost have changed as the probability of success changed