Determining least cost fertilizer mix.
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Frequently an agronomist may question if the fertilizer mix that is to be spread onto a field is a least cost mix.

Excel © contains a linear programming routine referred to as Solver that is most useful to solving this type of problem.

Our problem is to find the least cost formulation for a field that will require 162 lb of N, 68 lb of P_2O_5, 54 lb of K_2O, and 13 lb of sulfur. Note that these can be found in cells C14:C17 below.

	A	B	C	D
12			constraint	constraint
13		formula	lb/acre	ton/acre
14	constraints	0.0109	162	0.081
15		0.0101	68	0.034
16		0.0139	54	0.027
17		0.0042	13	0.0065
18		0.01		0
19		0.01		0
20		0.01		0
21		0.01		0
22		0.01		0
23		0.01		0

We will assume that we have 6 different fertilizers, cells A3:A8, to chose from that are listed below. Note that the formulation of these fertilizers are included in cells B3:E8. The cost for a ton of each formulation is found in cells G3:G8

	A	B	C	D	E	F	G	H	I
1			Analysis				cost	estimate	results
2		N	P2O5	K2O	S		$/ton	ton/acre	pounds/acre
3	Potassium Sulfate	0	0	0.52	0.18		125	0.01	20
4	Mono ammonium phosphate	0.11	0.55	0	0		255	0.01	20
5	Di ammonium phosphate	0.18	0.46	0	0		262	0.01	20
6	Ammonium sulfate	0.21	0	0	0.24		177	0.01	20
7	Potassium Nitrate	0.13	0	0.87	0		280	0.01	20
8	Urea	0.46	0	0	0		270	0.01	20

The objective function that we desire to minimize is the sum of the cost of the fertilizer. In cell B10 below is the equation defining this objective function of how much we will spend. As an example, the first term in cell B10 is $G$3, the cost of the Potassium Sulfate which is multiplied by the recommended amount to be applied in cell $H$3. The rest of the summed terms are the other possible fertilizers. This cell calculated the total amount to be spent.

	A	B
10	objective function	=$G$3*$H$3+$G$4*$H$4+$G$5*$H$5+$G$6*$H$6+$G$7*$H$7+$G$8*$H$8

There are a number of constraints that must be are part of this analysis. The objective function, B10 sums the total cost . Constraints add more information to the analysis. The formula in cell B14 calculates the amount of nitrogen that is to be applied.

	A	B	C	D
12			constraint	constraint
13		formula	lb/acre	ton/acre
14	constraints	0.0109	162	0.081
15		0.0101	68	0.034
16		0.0139	54	0.027
17		0.0042	13	0.0065
18		0.01		0
19		0.01		0
20		0.01		0
21		0.01		0
22		0.01		0
23		0.01		0

The underlying formulas listed below. The first term in cell B14 is found to be $B$3*$H$3. This portion of the total equation is calculating the amount of nitrogen that is to come from the potassium sulfate (obviously this is 0 but is included as a general solution). The constraint will be that the total nitrogen must be equal to or greater than the 162 lb/acre recommendation. (actually we will use the ton/ acre calculated in D14). Line 15 calculates P_2O_5, line 16 calculated K_2O, and line 17 calculates the S. Lines 18 through 23 are constraints indicating that the amount of each product must be greater than 0. As an example, line 18 says that the

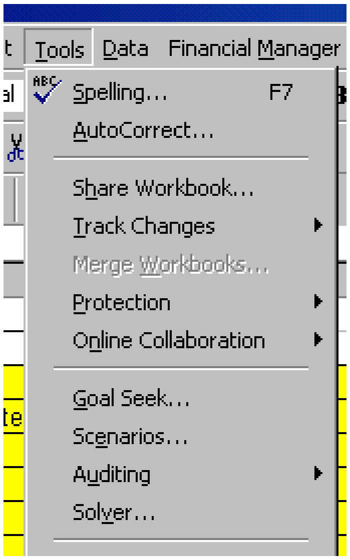
	B	C	D
13	formula	lb/acre	ton/acre
14	=$B$3*$H$3+$B$4*H$4+$B$5*$H$5+$B$6*$H$6+$B$7*$H$7+$B$8*$H$8	162	=C14/2000
15	=$C$3*$H$3+$C$4*H$4+$C$5*$H$5+$C$6*$H$6+$C$7*$H$7+$C$8*$H$8	68	=C15/2000
16	=$D$3*$H$3+$D$4*H$4+$D$5*$H$5+$D$6*$H$6+$D$7*$H$7+$D$8*$H$8	54	=C16/2000
17	=$E$3*$H$3+$E$4*H$4+$E$5*$H$5+$E$6*$H$6+$E$7*$H$7+$E$8*$H$8	13	=C17/2000
18	=$H$3		0
19	=$H$4		0
20	=$H$5		0
21	=$H$6		0
22	=$H$7		0
23	=$H$8		0

potassium sulfate cannot be a negative number for this makes no sense.

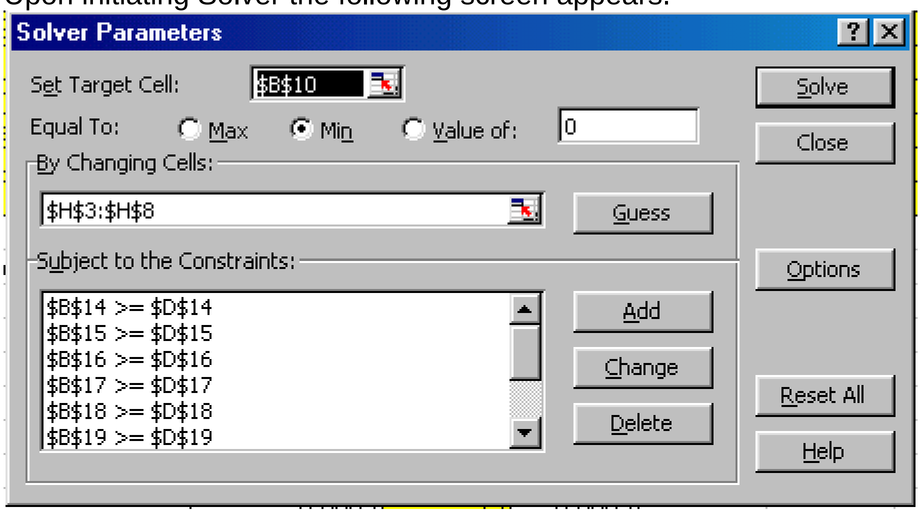
The formulas in the I column follow

	I
1	results
2	pounds/acre
3	=H3*2000
4	=H4*2000
5	=H5*2000
6	=H6*2000
7	=H7*2000
8	=H8*2000

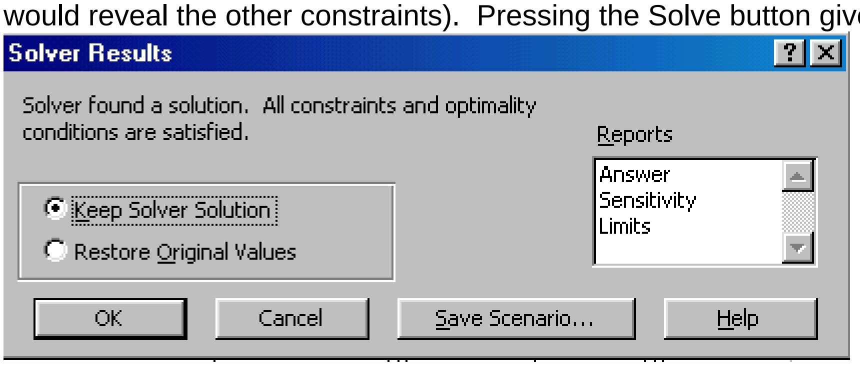
The following screen indicates that under the tool icon can be found a program called Solver.



Upon initiating Solver the following screen appears.



You will need to fill in the solver screens. Note that the objective function to be minimized is found in cell $B$10. The final answers (after invoking solver will be found) and initial estimates, (before invoking solver, I usually start with .01) are found in cells $H$3:h8 and the constraints are found in cells $B$14:$D$23. (the screen only goes to $D$19 but scrolling down would reveal the other constraints). Pressing the Solve button gives the following result.



Pressing the OK button clears the instruction screen.

	A	B	C	D	E	F	G	H	I
1			Analysis				cost	estimate	results
2		N	P2O5	K2O	S		$/ton	ton/acre	pounds/acre
3	Potassium Sulfate	0	0	0.52	0.18		125	0.036111	72.222222
4	Mono ammonium phosphate	0.11	0.55	0	0		255	0	0
5	Di ammonium phosphate	0.18	0.46	0	0		262	0.073913	147.82609
6	Ammonium sulfate	0.21	0	0	0.24		177	0	0
7	Potassium Nitrate	0.13	0	0.87	0		280	0.009451	18.90166
8	Urea	0.46	0	0	0		270	0.144494	288.98714
9									
10	objective function	65.5386							
11									
12			constraint	constraint					
13		formula	lb/acre	ton/acre					
14	constraints	0.081	162	0.081					
15		0.034	68	0.034					
16		0.027	54	0.027					
17		0.0065	13	0.0065					
18		0.036111		0					
19		0		0					
20		0.073913		0					

Results are found in cells I3:I8. Again, note that the minimum cost will be found in cell B10.