

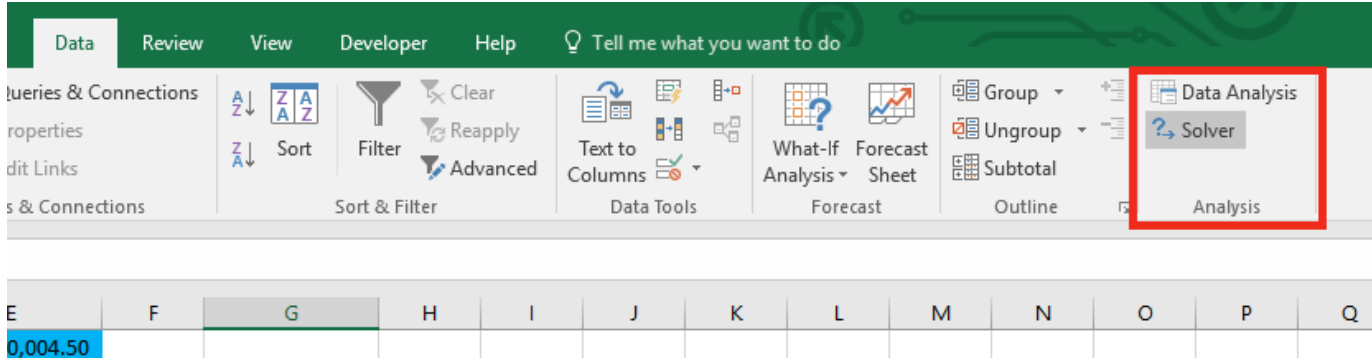
## Using Solver

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## Installing Solver for PC

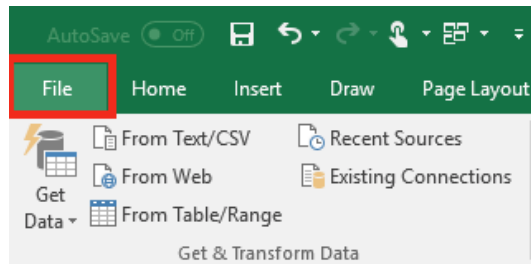
### Excel Step-by-Step How-to for PC

**Instructions:** Use this guide to install Solver onto a PC computer.

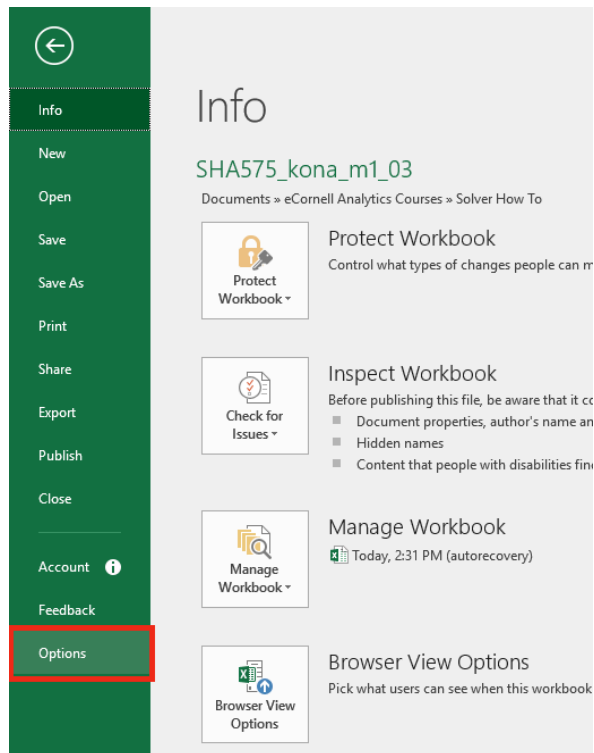
Step	Instructions + Screen Shot
1. Check whether Solver is already installed.	<p>Navigate to the Data tab and look for the Solver button under the Analysis category.</p>  <p>The screenshot shows the Excel ribbon with the 'Data' tab selected. The 'Analysis' group on the right side of the ribbon contains the 'Solver' button, which is highlighted with a red rectangle. The ribbon also shows other groups like 'Sort &amp; Filter', 'Data Tools', 'Forecast', and 'Outline'. The spreadsheet area below the ribbon shows columns E through Q, with cell E1 containing the value 0,004.50.</p>

2. If Solver is not present, add Solver using Excel Options.

Start by clicking the File Button.

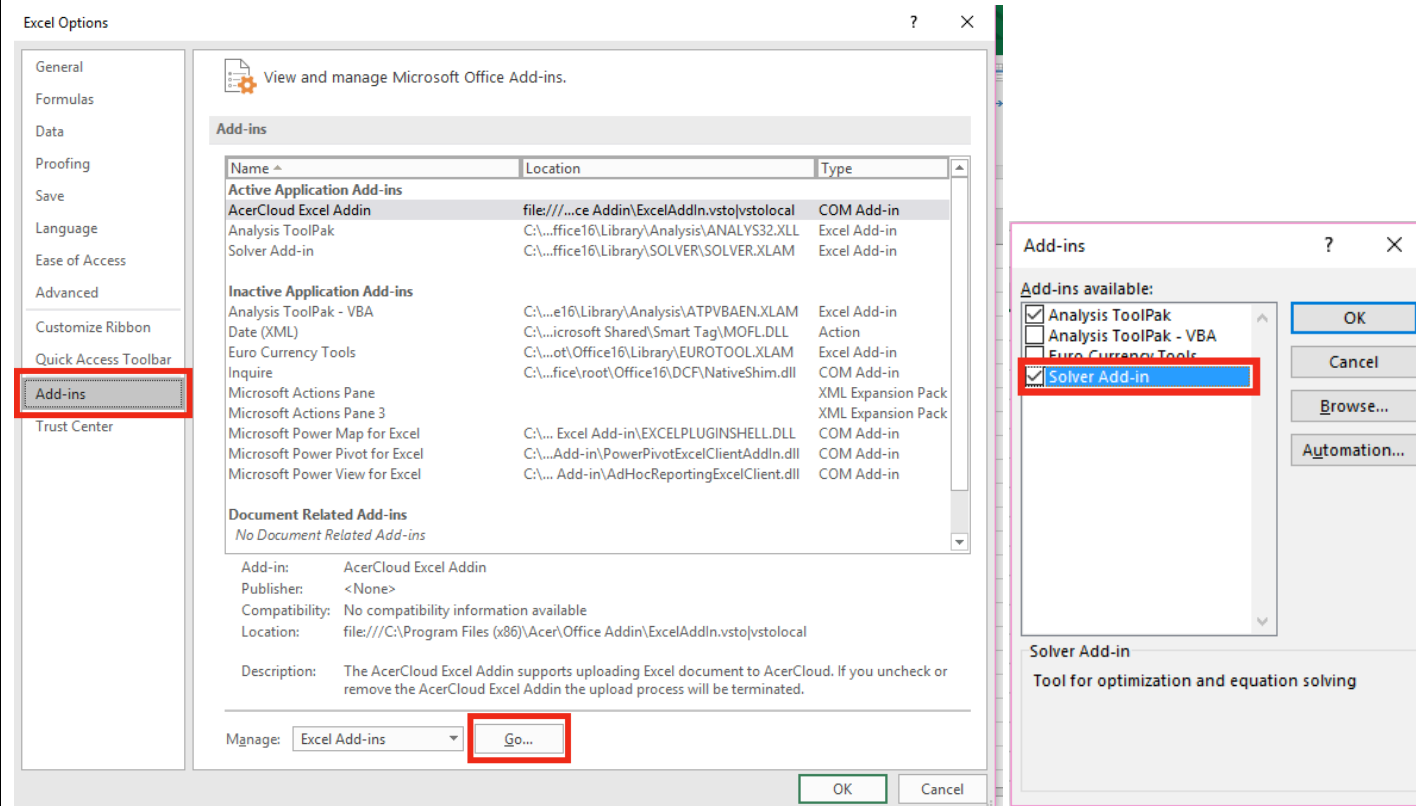


Navigate to the bottom of the list on the left of the screen and select Options.



3. Add the Solver Excel Add-In.

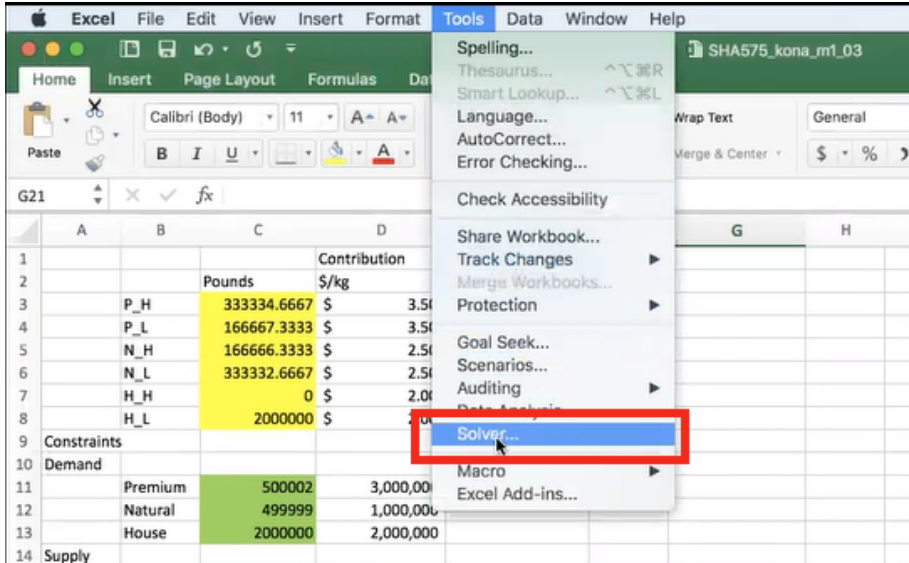
Navigate to the Add-ins tab. Make sure that the “Manage” drop down is set to Excel Add-Ins and click Go. Check the box beside Solver Add-in and click OK.



## Install Solver on Mac Computer

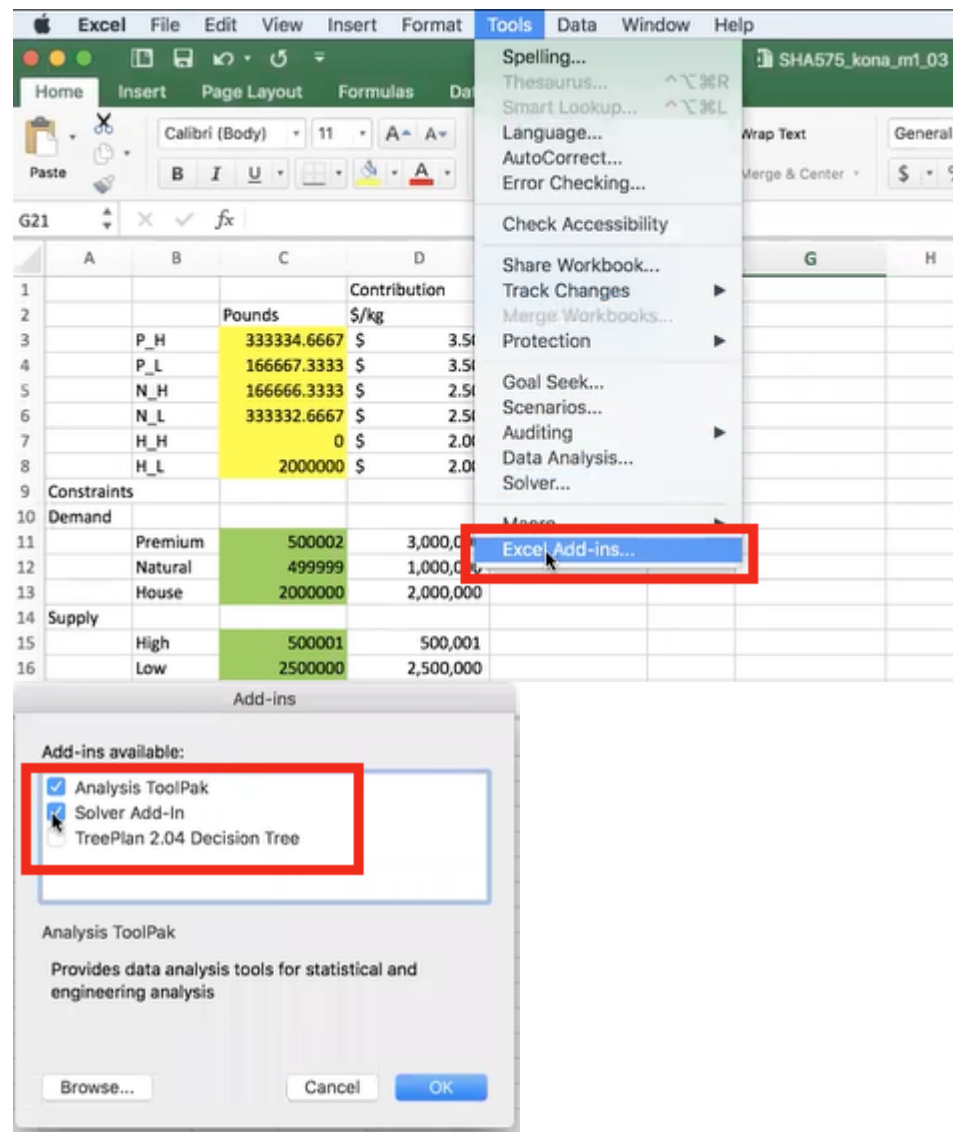
### Excel Step-by-Step How-to for Mac

**Instructions:** Use this guide to install Solver to a Mac computer.

Step	Instructions + Screen Shot
1. Check whether Solver is already installed.	<p>Navigate to the tools tab and search for the Solver menu item.</p>  <p>The screenshot shows the Excel application window with the 'Tools' menu open. The menu items include: Spelling..., Thesaurus..., Smart Lookup..., Language..., AutoCorrect..., Error Checking..., Check Accessibility, Share Workbook..., Track Changes, Merge Workbooks..., Protection, Goal Seek..., Scenarios..., Auditing, Solver..., Macro, and Excel Add-ins.... The 'Solver...' option is highlighted with a red rectangle.</p>

2. If Solver is not present, add it to the Excel Add-ins.

Navigate to the tools tab and select Excel Add-ins. Check the box for the Solver Add-in and click OK.



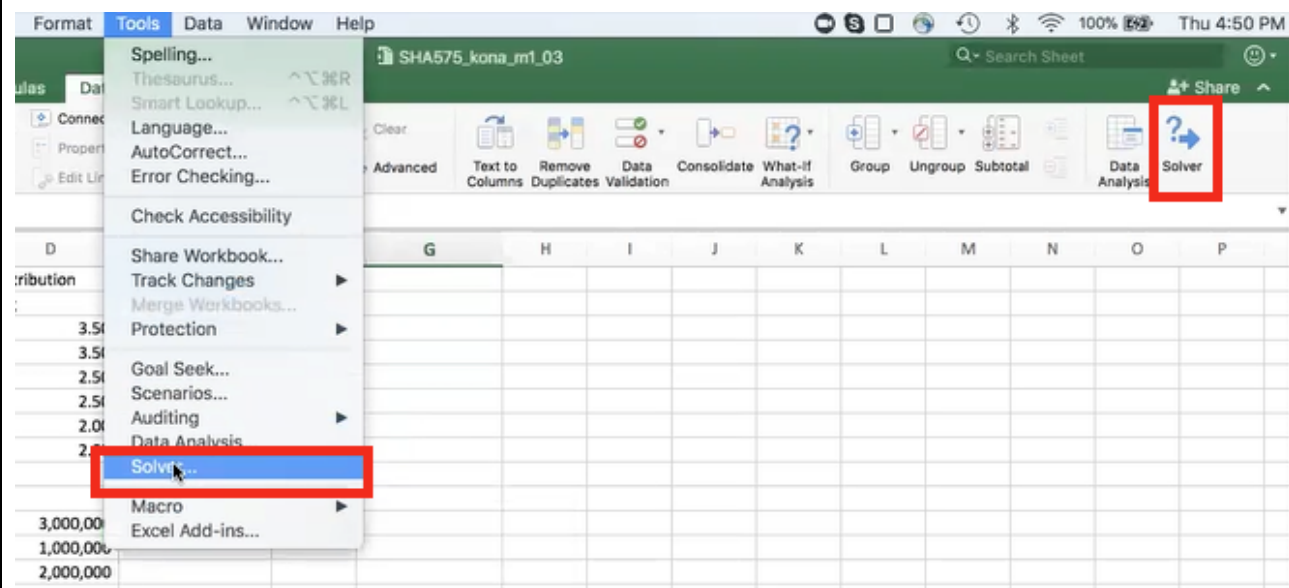
## Using Solver

### Excel Step-by-Step How-to

**Instructions:** Use this guide to learn how to use the functions of Solver.

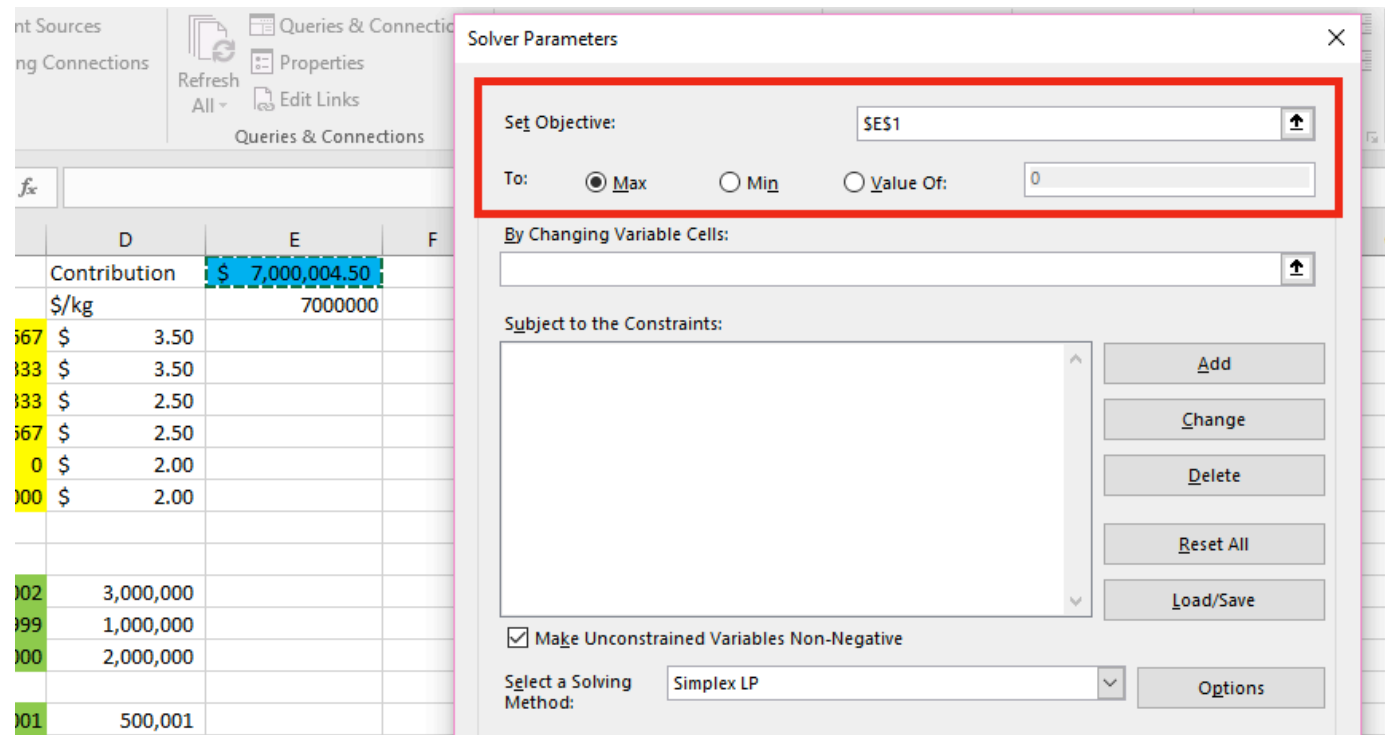
**Data requirement:** fixed values, constraints, two or more decision variables, one or more dependent objective function

**Sample Data:** coffee blends

Step	Instructions + Screen Shot
1. Launch Solver.	<p>Either select the Solver title under the tools tab or navigate to the Data tab on the ribbon and select the Solver button.</p> 

2. Select the objective cell and whether you would like the cell to be maximized, minimized, or equal to a value.

This example has the objective of maximizing the contribution in cell E1. In this case, contribution represents a total revenue based on the =SUMPRODUCT of prices for different products and sales figures for each product.



The screenshot shows the Excel Solver Parameters dialog box overlaid on a spreadsheet. The dialog box is titled "Solver Parameters" and has a red border around the "Set Objective:" section. In this section, the "Set Objective:" field is set to "\$E\$1", and the "To:" radio buttons are set to "Max". The "By Changing Variable Cells:" field is empty. The "Subject to the Constraints:" section is empty. The "Make Unconstrained Variables Non-Negative" checkbox is checked. The "Select a Solving Method:" dropdown is set to "Simplex LP".

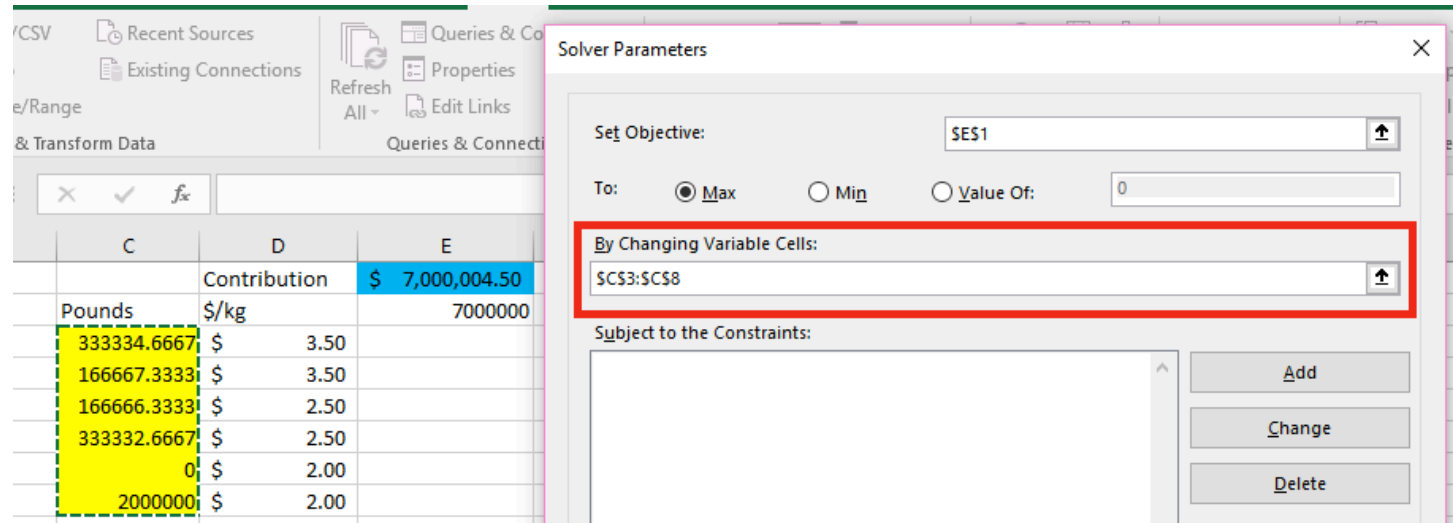
The spreadsheet shows a table with columns D, E, and F. The table contains the following data:

	D	E	F
Contribution		\$ 7,000,004.50	
\$/kg		7000000	
67	\$ 3.50		
33	\$ 3.50		
33	\$ 2.50		
67	\$ 2.50		
0	\$ 2.00		
00	\$ 2.00		
02	3,000,000		
99	1,000,000		
00	2,000,000		
01	500,001		



3. Specify the decision variable cells within the Solver dialog box.

This example has decision variables in cells C3:C8. While this screenshot shows values determined after Solver has been run, it is customary to pre-populate decision variable cells with a uniform value, such as 1. To specify the decision variables in Solver you can either key in the cell identifier (or range) in the “By Changing Variable Cells:” field, or select the RefEdit icon (short up arrow with the line below it) and then select the target cell(s) in the sheet.

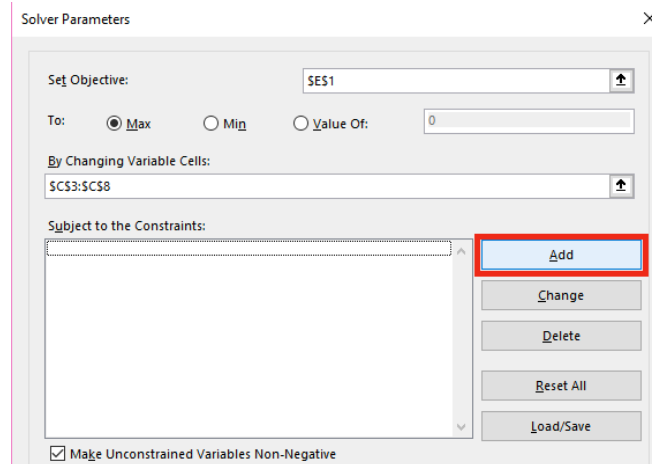


	C	D	E
		Contribution	\$ 7,000,004.50
	Pounds	\$/kg	7000000
	333334.6667	\$ 3.50	
	166667.3333	\$ 3.50	
	166666.3333	\$ 2.50	
	333332.6667	\$ 2.50	
	0	\$ 2.00	
	2000000	\$ 2.00	

#### 4. Add constraints.

**TIP:** You can add multiple constraints at a time if they are in adjacent cells and are of the same type.

Select the Add button.



Solver Parameters

Set Objective:

To: ☒ Max ☐ Min ☐ Value Of:

By Changing Variable Cells:

Subject to the Constraints:

☒ Make Unconstrained Variables Non-Negative

Input the cells that apply to the constraints. This example states that the premium, natural, and house should be less than or equal to three, one, and two million respectively. Select OK.

	A	B	C	D	E	F
1						
2				Contribution		
3	coffee blend	bean quality	kilograms	\$ earned/kg of bean		
4	premium	high	333333.333	\$ 3.50		
5		low	166666.667	\$ 3.50		
6	natural	high	166666.667	\$ 2.50		
7		low	333333.333	\$ 2.50		
8	house	high	0	\$ 2.00		
9		low	2000000	\$ 2.00		
10					\$ 7,000,000.00	profit
11	Demand for each blend		kilograms	maximum allowed		
12		Premium	500000	3,000,000		
13		Natural	500000	1,000,000		
14		House	2000000	2,000,000		
15	Supply of each bean type					
16		high quality	500000	500,000		
17		low quality	2500000	2,500,000		
18	H/L bean quality balance			minimum allowed		
19		Premium	0	0		
20		Natural	0	0		
21						

Add Constraint

Cell Reference:

Constraint:

\$C\$11:\$C\$13

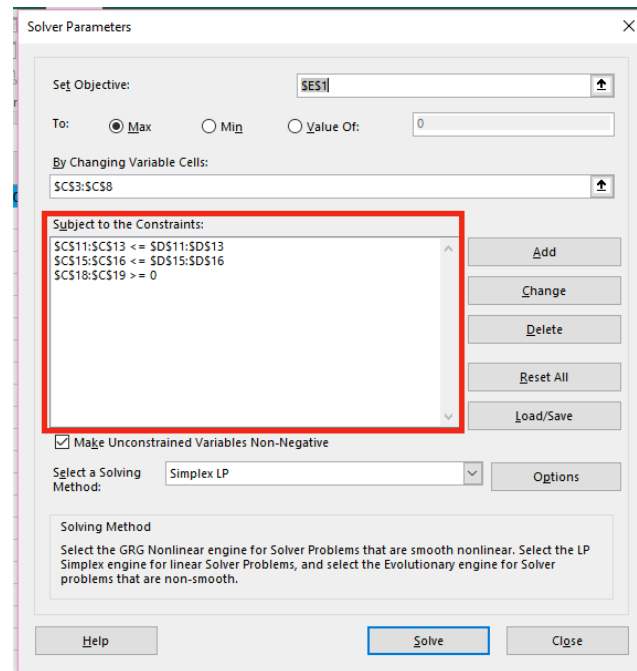
<=

=\$D\$11:\$D\$13

OK
Add
Cancel

Add multiple constraints by selecting the Add button again. Constraints will accumulate in the identified box.

Note that in this example all three demand constraints can be added in a single add action because they are adjacent rows and all three have a  $\leq$  relationship with the constraint limit cells. The supply constraints cells also have a  $\leq$  relationship with the constraint limit cells, but they must be added separately because they are not adjacent to the demand cells.



Solver Parameters

Set Objective:

To: ☒ Max ☐ Min ☐ Value Of:

By Changing Variable Cells:

Subject to the Constraints:

- 
- 
- 

☒ Make Unconstrained Variables Non-Negative

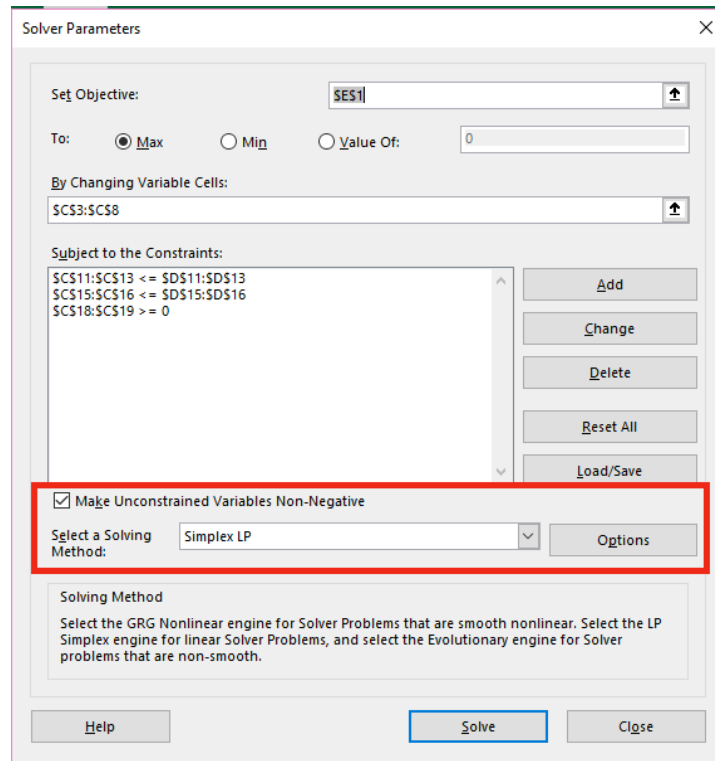
Select a Solving Method:

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.

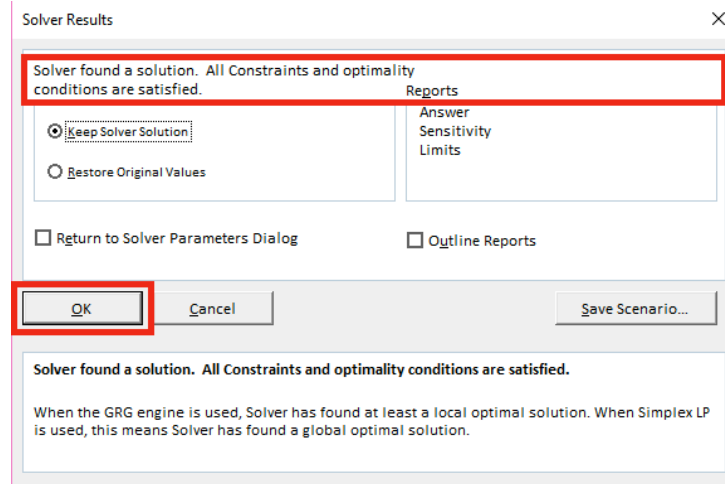
6. Select a solving method, and consider whether you need to make unconstrained variables non-negative.

Use the dropdown to select the appropriate solving method. If the decision variables for the model should be non-negative then select this check box. Select Solve to initiate the Solver analysis.



7. Review the outcome of the Solve attempt.

Note that the Solver has found a solution in this example. “Solver found a solution. All constraints and optimality conditions are satisfied.” Select OK to see data.



The Solver Results dialog box shows the message: "Solver found a solution. All Constraints and optimality conditions are satisfied." The "Keep Solver Solution" radio button is selected. The "OK" button is highlighted with a red box.

	A	B	C	D	E
1				Contribution	\$ 7,000,004.50
2			Pounds	\$/kg	7000000
3		P_H	333334.6667	\$ 3.50	
4		P_L	166667.3333	\$ 3.50	
5		N_H	166666.3333	\$ 2.50	
6		N_L	333332.6667	\$ 2.50	
7		H_H	0	\$ 2.00	
8		H_L	2000000	\$ 2.00	
9	Constraints				
10	Demand				
11		Premium	500002	3,000,000	
12		Natural	499999	1,000,000	
13		House	2000000	2,000,000	
14	Supply				
15		High	500001	500,001	
16		Low	2500000	2,500,000	
17	Quality				
18		Premium	0	-	
19		Natural	0	-	
20					

Some other typical result messages include:

Message	Suggested action
The linearity conditions required by this LP Solver are not satisfied. (linear only)	Select a non-linear method (e.g. GRG or Evolutionary)
Solver cannot improve the current solution. All constraints are satisfied. (non-linear only)	Good result. Select OK to see data
Solver could not find a feasible solution. (non-linear only)	Adjust the parameters of the solve method and re-run Solver.

For a more complete list of Solver result messages, see: <https://www.solver.com/excel-solver-solver-result-messages>

## Using Solver to Run a Sensitivity Analysis

### Excel Step-by-Step How-to

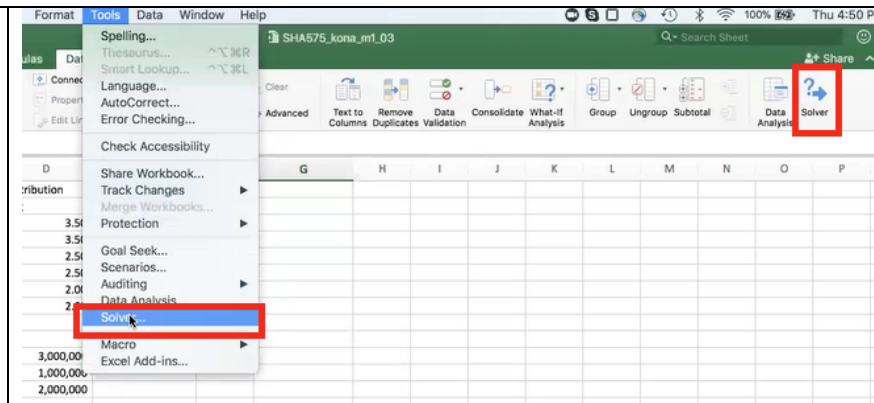
**Instructions:** Use this guide to use Solver to run a sensitivity analysis.

**Data requirement:** A model that has been analyzed with Solver. See how-to on [page 7](#).

**Sample Data:** coffee blends

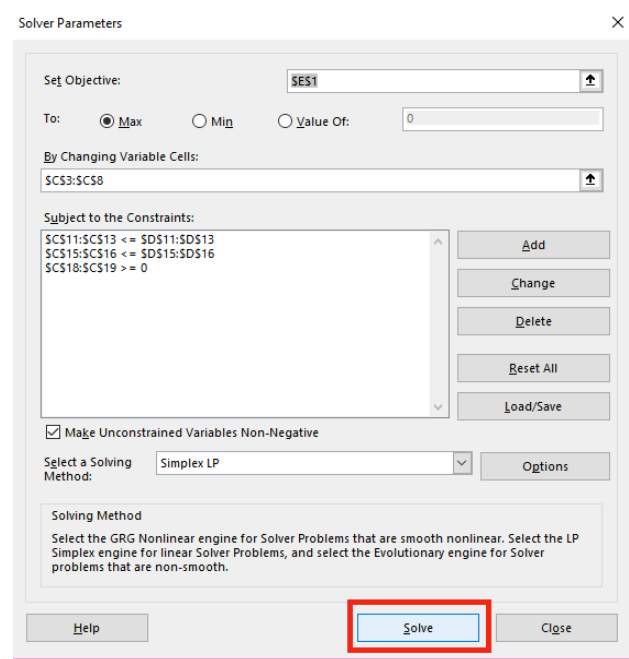
Step	Instructions + Screenshot
1. Complete analysis from previous how-to.	<a href="#">Using Solver How-To</a>
2. Launch Solver.  <b>TIP: On the Mac platform, avoid having more than one workbook that uses Solver</b>	Either select the Solver title under the tools tab or navigate to the Data tab on the ribbon and select the Solver button.

open at any given time. Solver sometimes jumps between workbooks when running, and this can lead to confusion.



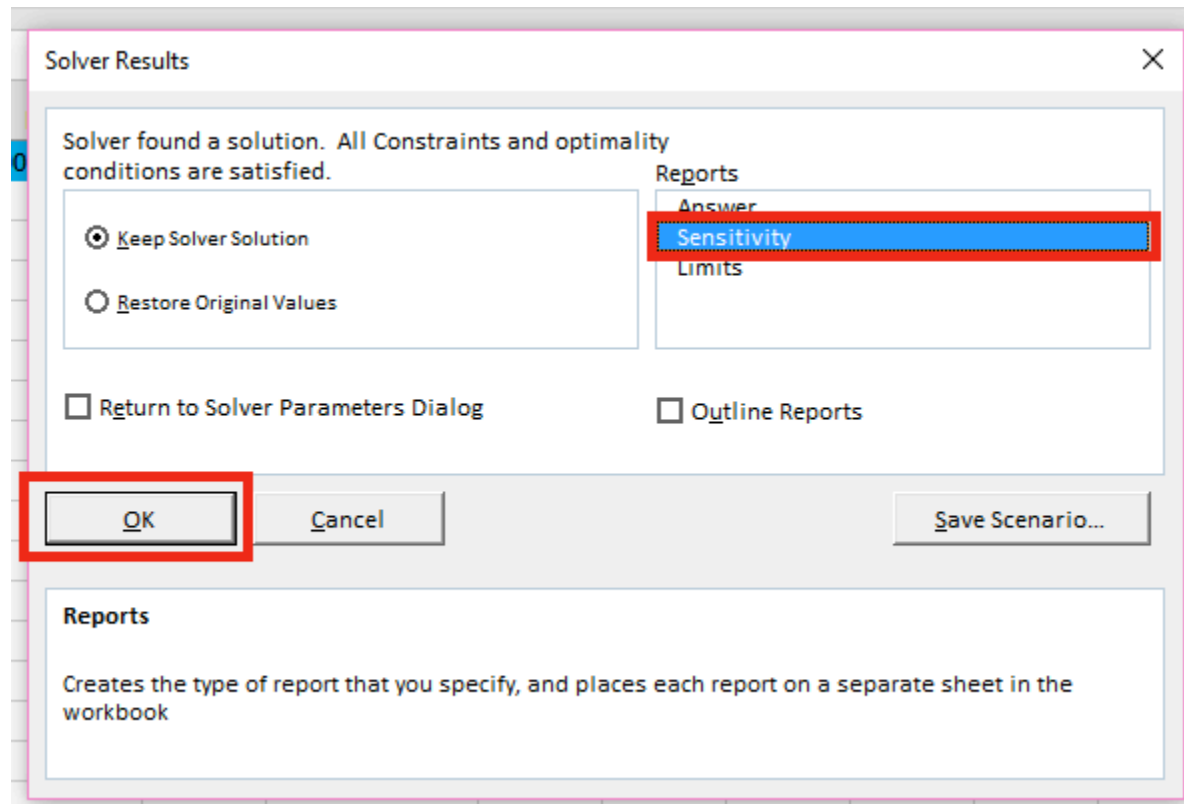
3. Run a sensitivity analysis on the model.

Make sure your objective and constraints are specified correctly. Then select Solve.





Select the Sensitivity Report option. Then select OK.

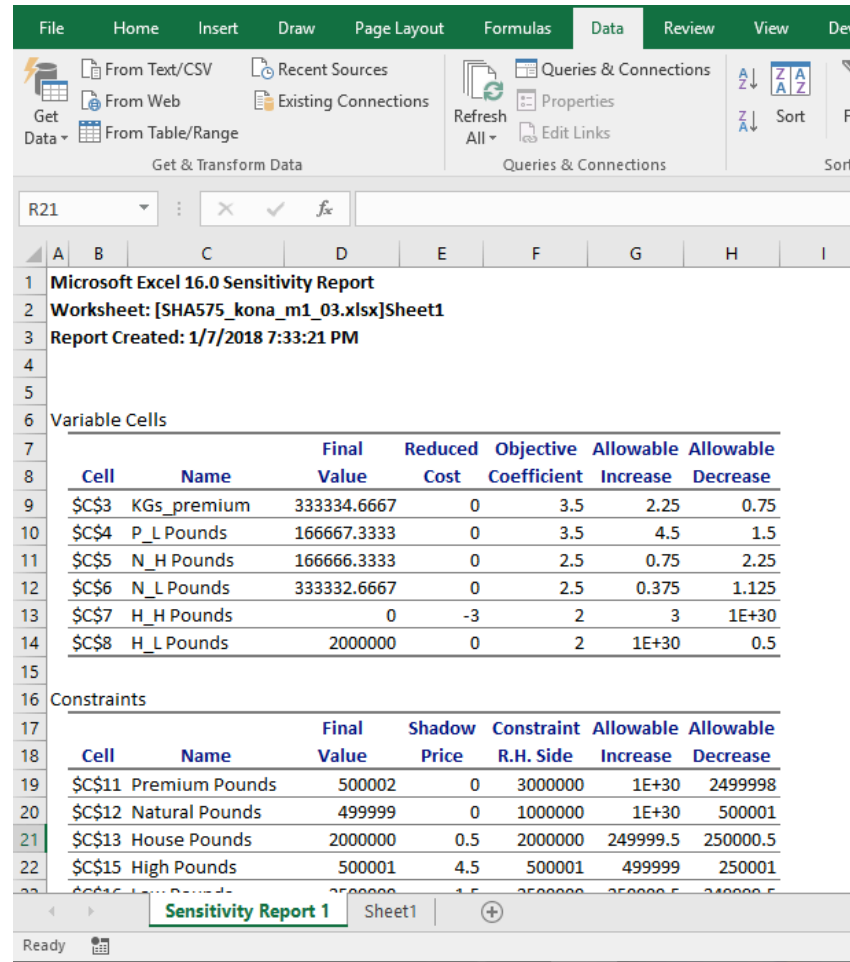


#### 4. Review sensitivity report.

The sensitivity report will appear in a new sheet.

The first report you create in a workbook will appear in a sheet labeled Sensitivity Report 1.

Subsequent analyses will be placed in separate sheets labeled Sensitivity Report 2, Sensitivity Report 3, etc.



**Microsoft Excel 16.0 Sensitivity Report**  
Worksheet: [SHA575\_kona\_m1\_03.xlsx]Sheet1  
Report Created: 1/7/2018 7:33:21 PM

**Variable Cells**

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
\$C\$3	KGs_premium	333334.6667	0	3.5	2.25	0.75
\$C\$4	P_L Pounds	166667.3333	0	3.5	4.5	1.5
\$C\$5	N_H Pounds	166666.3333	0	2.5	0.75	2.25
\$C\$6	N_L Pounds	333332.6667	0	2.5	0.375	1.125
\$C\$7	H_H Pounds	0	-3	2	3	1E+30
\$C\$8	H_L Pounds	2000000	0	2	1E+30	0.5

**Constraints**

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
\$C\$11	Premium Pounds	500002	0	3000000	1E+30	2499998
\$C\$12	Natural Pounds	499999	0	1000000	1E+30	500001
\$C\$13	House Pounds	2000000	0.5	2000000	249999.5	250000.5
\$C\$15	High Pounds	500001	4.5	500001	499999	250001