

How to Conduct On-Farm Trials

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How can you determine whether a treatment (this might be an additive, a fertilizer, snake oil, etc.), cultivar, or management practice is effective?

Test it for yourself in your orchard

- Treat part(s) of your orchard with the material
- Leave part(s) untreated
- Measure tree response
 - Yield
 - Leaf analysis
 - Nut quality
 - Etc.
- Compare response of treated versus untreated



How do we decide if something is better?

- We need at least two 'treatments' so we can make a comparison
- We need an objective way of evaluating the two treatments
- Statistics can help us determine if a treatment actually affects plant performance

On average who's taller - men or women?

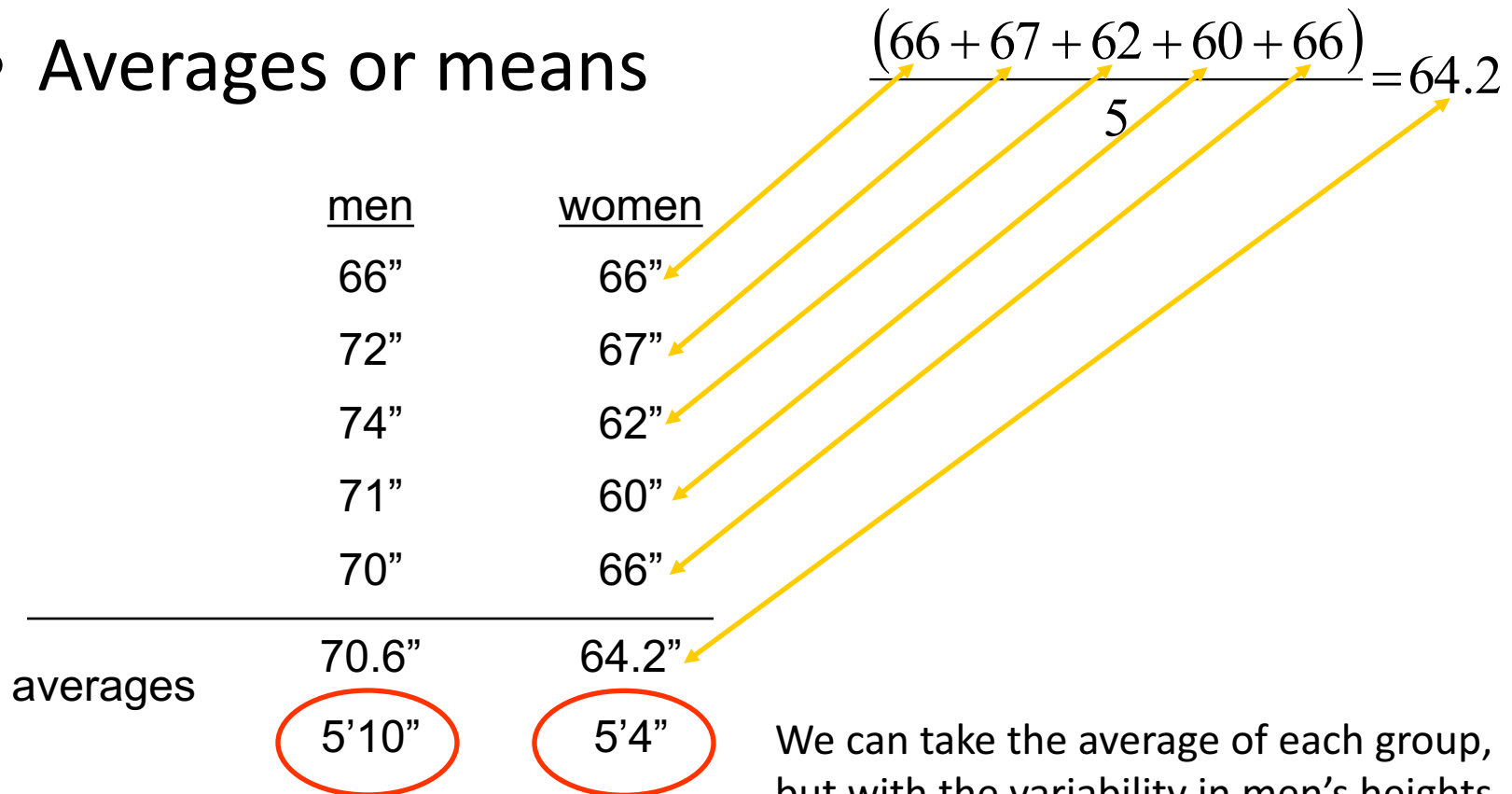


<u>Men's heights</u>					<u>Women's heights</u>				
5'6"	6'0"	6'2"	5'11"	5'10"	5'6"	5'7"	5'2"	5'0"	5'6"
66"	72"	74"	71"	70"	66"	67"	62"	60"	66"

In our samples there is a range of heights of both men and women. Men's heights range from 66 to 74", women 60 to 67". Some women are taller than some men.

Sample statistics

- Averages or means

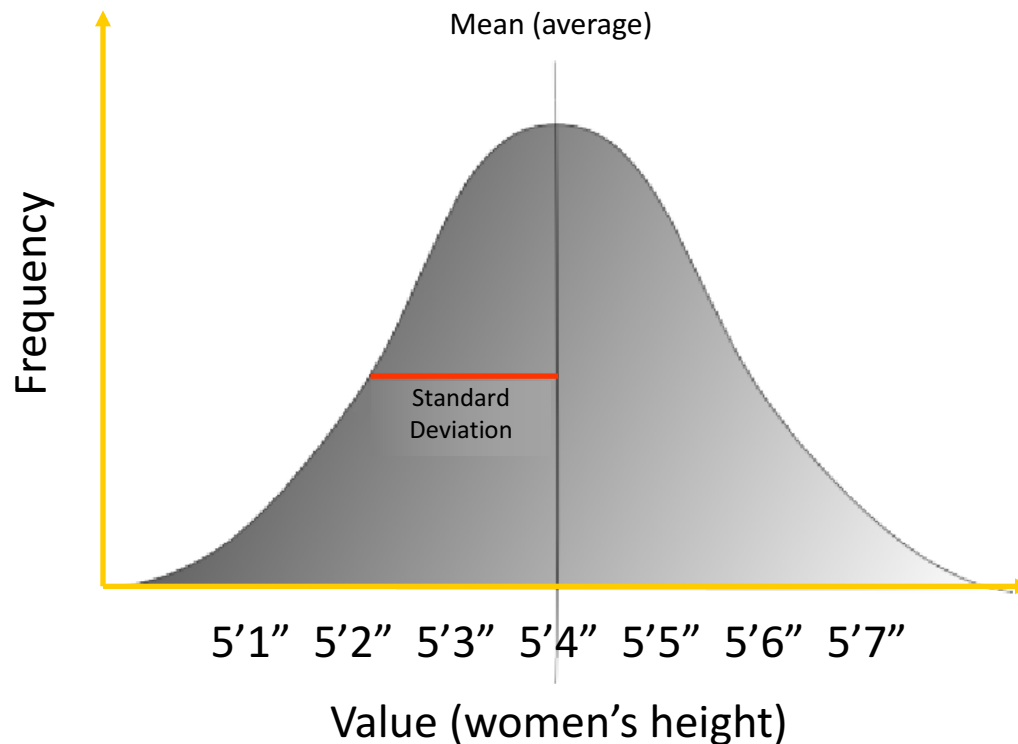


We can take the average of each group, but with the variability in men's heights and in women's heights, how do we know if these numbers really different?

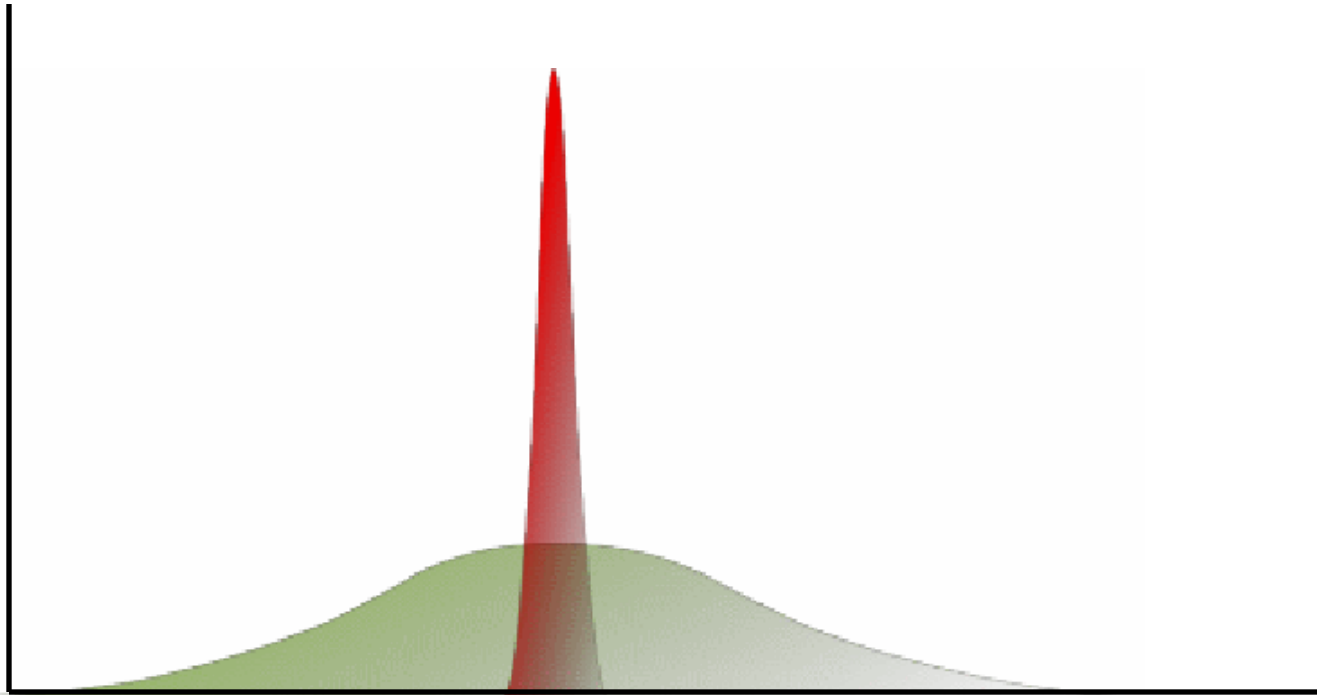
- We start by evaluating the spread (statisticians use measures of variance or standard deviation)

$$\text{standard deviation} = \sqrt{\text{variance}}$$

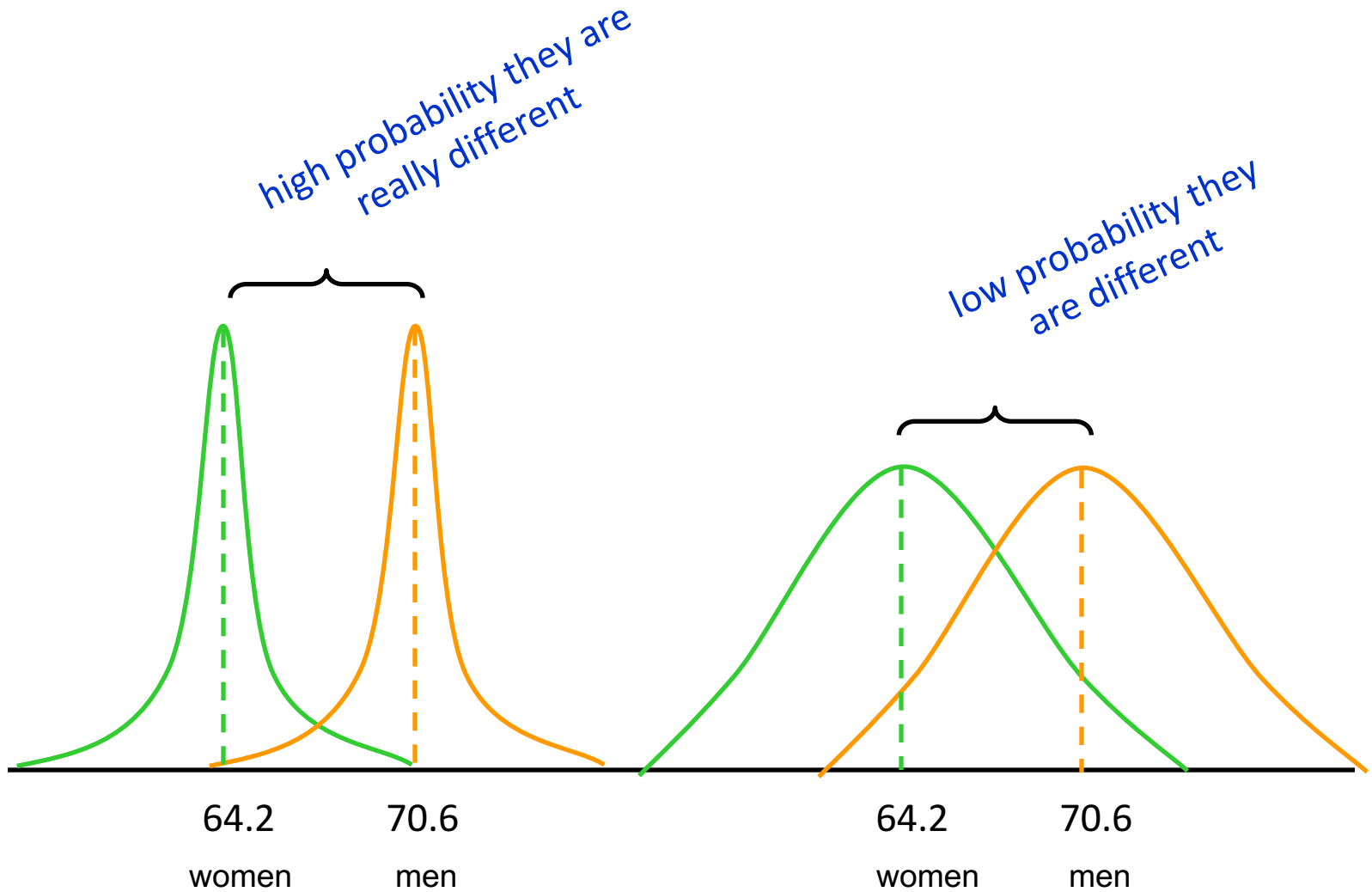
$$\text{coefficient of variation} = \frac{\text{standard deviation}}{\text{mean}} \times 100$$



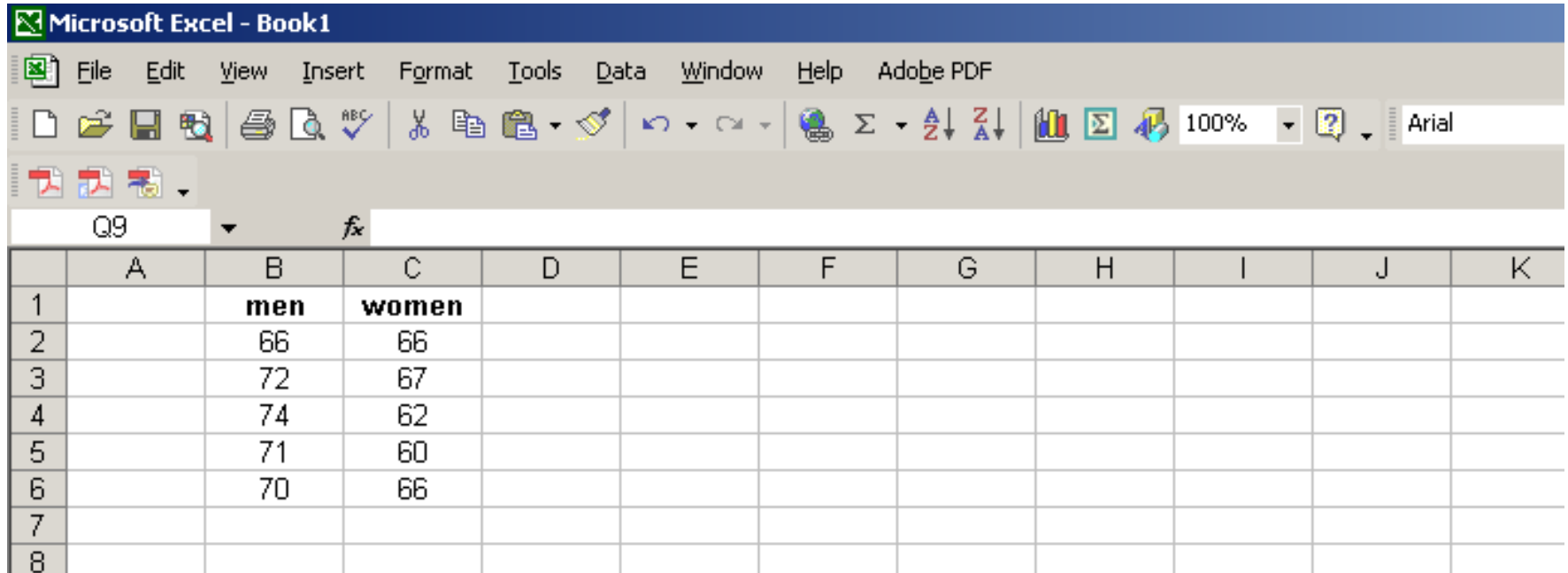
Groups or populations with large
(green) and small (red) spreads



Comparing groups with small versus large spreads



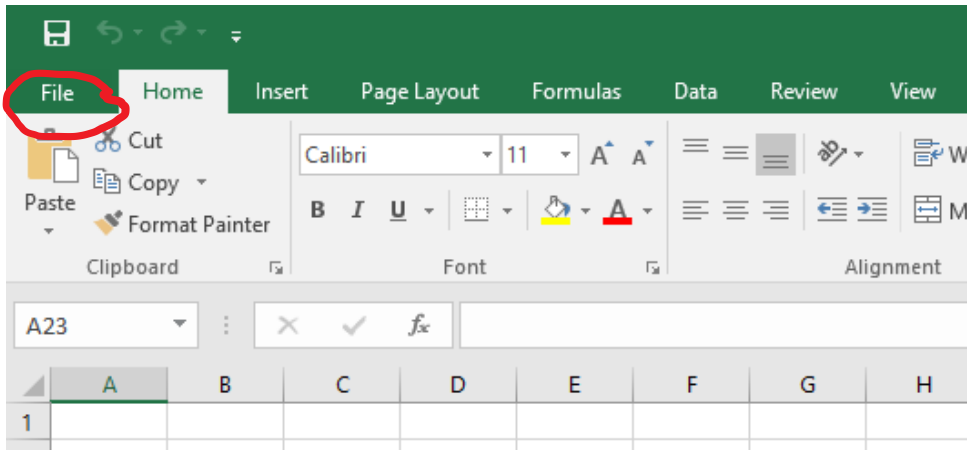
Analysis of Variance (ANOVA) using Microsoft Excel



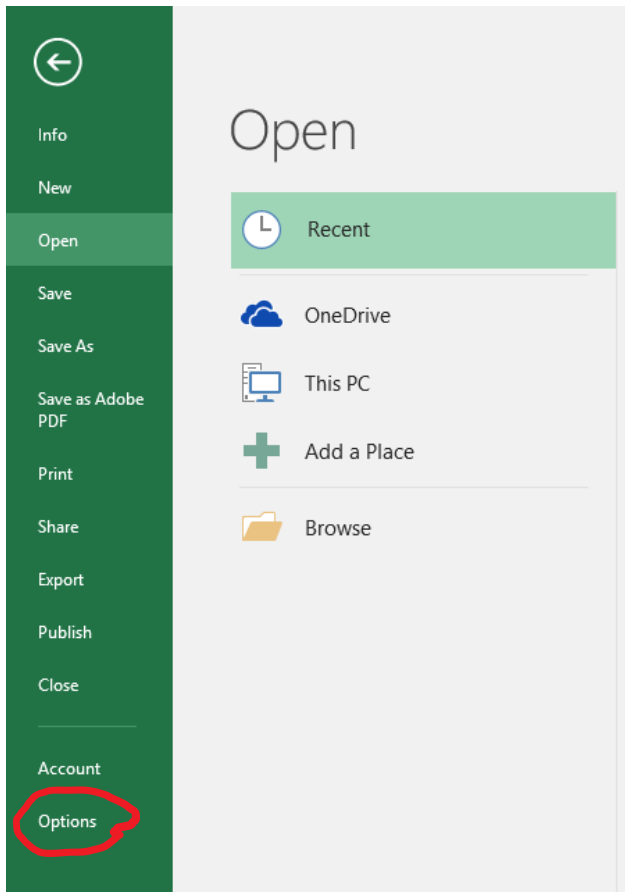
The screenshot shows the Microsoft Excel interface with a data table. The table has two columns labeled 'men' and 'women' under the header row. The data values are as follows:

	A	B	C	D	E	F	G	H	I	J	K
1		men	women								
2		66	66								
3		72	67								
4		74	62								
5		71	60								
6		70	66								
7											
8											

In Microsoft Excel, enter the data in two columns, one for each 'treatment' (here men and women)

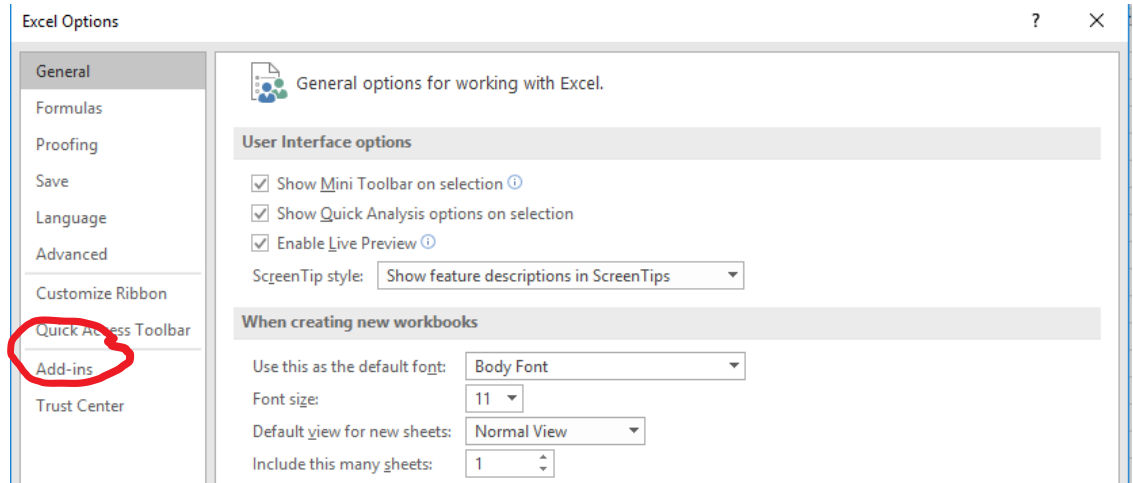


In Microsoft Excel (Office Professional 2016), go to 'File'

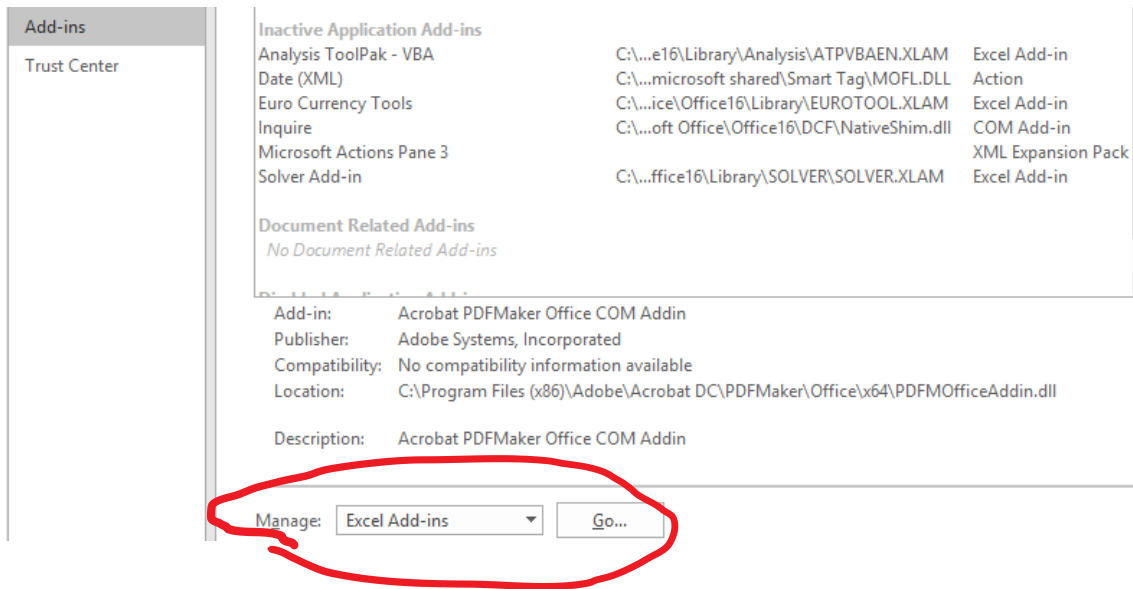


Then to 'Options'

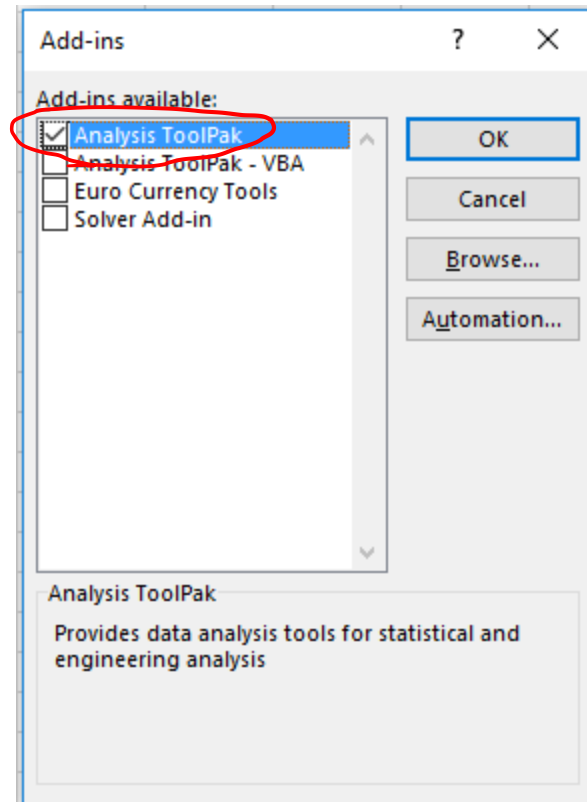
Then to 'add-ins'



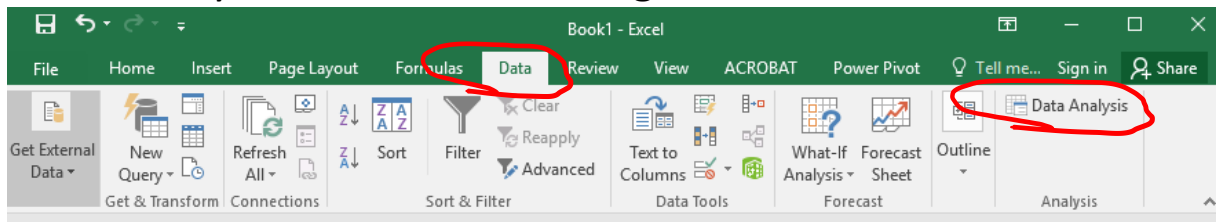
Select Excel Add-ins and click 'Go'



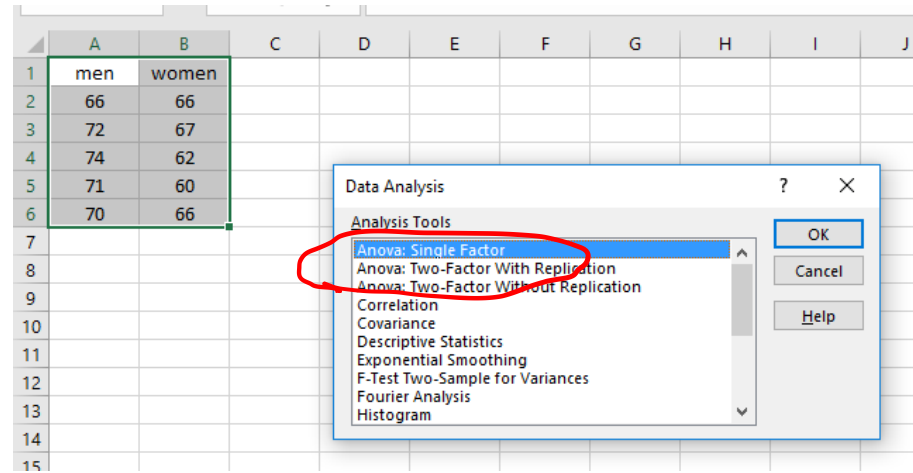
Select 'Analysis ToolPack' and 'OK'



Now when you click on 'Data' you'll see a 'Data Analysis' tab over to the right.

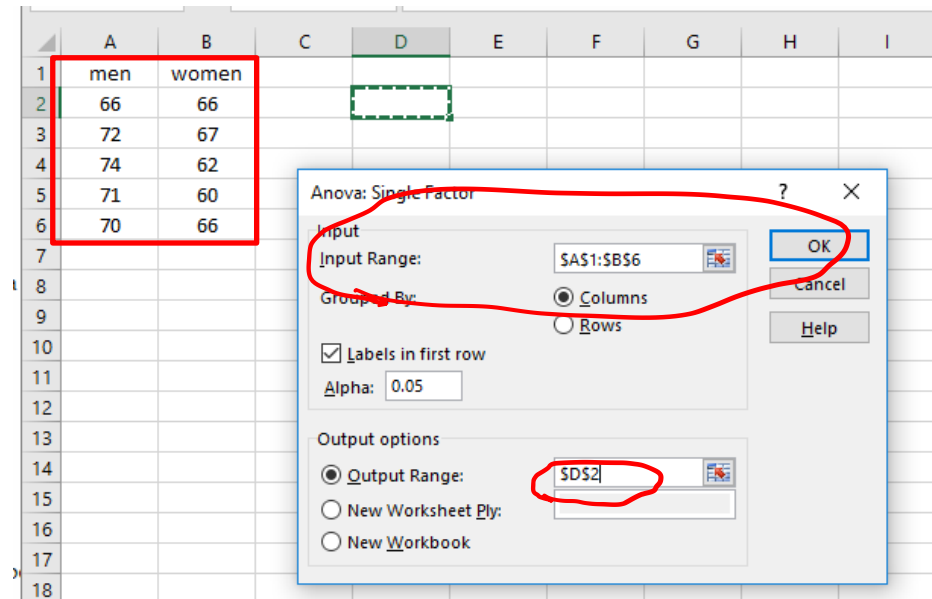


Select 'Anova: single factor'



Select 'Anova: single factor'

Tell Excel where to find your data and where you want the analysis output



	A	B	C	D	E	F	G	H	I	J	K
1	men	women									
2	66	66		Anova: Single Factor							
3	72	67									
4	74	62		SUMMARY							
5	71	60		<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>			
6	70	66		men	5	353	70.6	8.8			
7				women	5	321	64.2	9.2			
8											
9											
10				ANOVA							
11				<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>	
12				Between Groups	102.4	1	102.4	11.37778	0.009741	5.317655	
13				Within Groups	72	8	9				
14											
15				Total	174.4	9					
16											

Averages

The P value tells whether or not the two means are significantly different. The P value is the probability that the two means *are not* different. In this case there is a 0.97% chance that the means are not different, or a 99.03% chance that they really are different.

Conclusion: Men are taller than women!

Note: in scientific research we generally consider means to be different if the ANOVA tells us there is at least a 90-95% chance that they are different.

Orchard research

- You need at least two treatments so you can make a comparison
- Treatments must be replicated (we like to see at least 4 replicates)
 - The difference between replicates of each treatment give us a measure of the variance (spread or variability of the data)
 - Replicates should be arranged in a randomized fashion so that difference in the field (soil properties, slope, elevation, water, etc.) do not unfairly influence one treatment







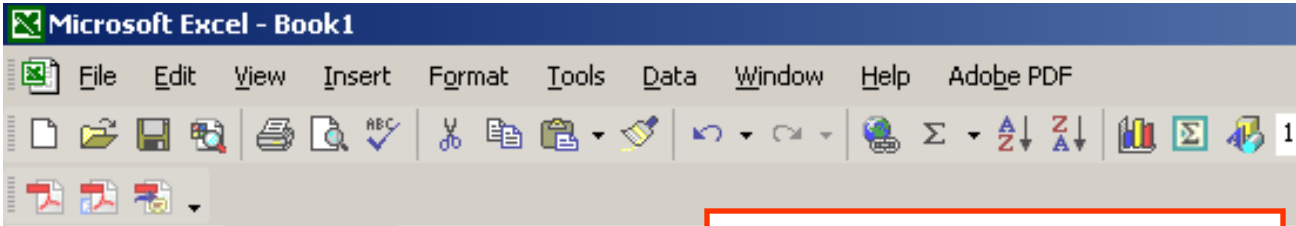
We've divided this orchard block into ten sections, each one an irrigation panel.



Let's suppose we want to compare two treatments: A and B. These might be two fertilizer materials. Each pair of panels is one replicate. We randomly assign each panel in a replicate one of the treatments, A or B.



We collect data from each panel individually, so we have five 'A' measurements and five 'B' measurements. Measurements could be nut yield (shown on figure), leaf nutrient levels, insect populations, etc.



	A	B	C
1		A	B
2		3375	3455
3		3020	3220
4		3005	3140
5		3065	3220
6		2925	3010

According to the treatment averages treatment 'B' was better than treatment 'A'

In this case, it looks like the snake oil decreased nut yield

Groups	Count	Sum	Average	Variance
A	5	15390	3078	30120
B	5	16045	3209	26280

But the analysis of variance indicates that there is a 25% chance that the averages are not significantly different, so we *can not* say that treatment 'B' was really better. There is a good chance that differences between the averages were just caused by random variability.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	42902.5	1	42902.5	1.521365	0.252422	5.317645
Within Groups	225600	8	28200			
Total	268502.5	9				

Other considerations

- Sometimes real randomization is not possible
 - You can still replicate and conduct an analysis of variance, but there's a chance that observed difference will be from field variation, not the treatments
 - Replicates always must be sampled or harvested separately
- It is a good idea to leave 'buffer' rows that separate treatments, so adjacent treatments are not affected
 - This is particularly important with things like spray treatments, but even hedging one row will affect the next row
 - Treatments could be applied to every other row
- Local Cooperative Extension personnel can help you set up and analyze field research

