

Potato and Wheat Yields from Fertilised and Unfertilised Fields

Name/Date

Introduction

A group of farmers is interested in whether a specific fertiliser will increase their annual yield of potatoes and wheat. The fertiliser under investigation is applied to the potato crops grown in a total of 130 different fields, whilst 80 fields growing potatoes are left unfertilised. Similarly, the fertiliser is applied in 90 different fields growing wheat, and 120 other wheat fields are left unfertilised. The yield (in tonnes) of the crop grown in each field is measured and reported.

This analysis investigates whether:

1. There is a difference between the mean yields of potatoes from fields that were fertilised and from fields that were left unfertilised.
2. There is a difference between the mean yields of wheat from fields that were fertilised and from fields that were left unfertilised.

Exploratory Analysis

The sample mean potato and wheat yields from fertilised and unfertilised fields are given in Table 1. The sample mean yield of potatoes from fertilised fields is slightly greater than the sample mean yield from unfertilised fields, but both means seem to be approximately equal here. The sample mean yield of wheat from fertilised fields is greater than the sample mean yield of wheat from unfertilised fields.

Table 1: Sample mean yield of potato and wheat yields (in tonnes) from fields which were fertilised and from fields which were unfertilised.

	Fertilised	Unfertilised
Potato	38.75	37.60
Wheat	23.80	17.98

Histograms of the potato yields from fertilised and unfertilised fields are shown in Figure 1. These suggest that the mean yield of potatoes is approximately equal in fertilised and unfertilised fields and that the standard deviation in these yields is also approximately equal in both fertilised and unfertilised fields.

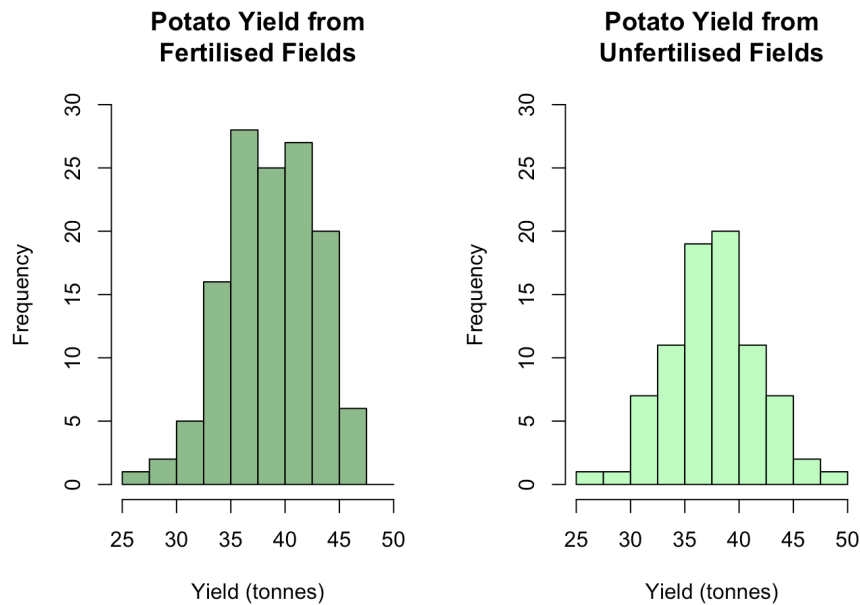


Figure 1: Histograms of potato yields (in tonnes) from fields which are fertilised and fields which are unfertilised.

QQ-plots of the potato yields from all fertilised and unfertilised fields are shown in Figure 2. These suggest that both sets of yields approximately follow a normal distribution.

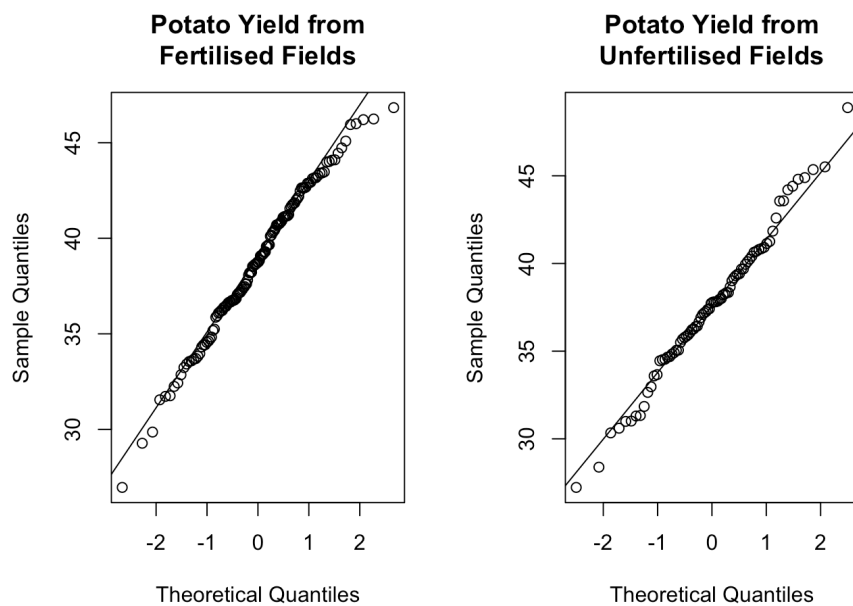


Figure 2: QQ-plots of potato yields (in tonnes) from fields which are fertilised and fields which are unfertilised.

Histograms of the wheat yields from fertilised and unfertilised fields are shown in Figure 3. These suggest that the mean yield of wheat from fertilised fields is greater than the mean yield of wheat from unfertilised fields. The sample standard deviation of wheat yields from fertilised fields seems to be greater than the sample standard deviation of wheat yields from unfertilised fields.

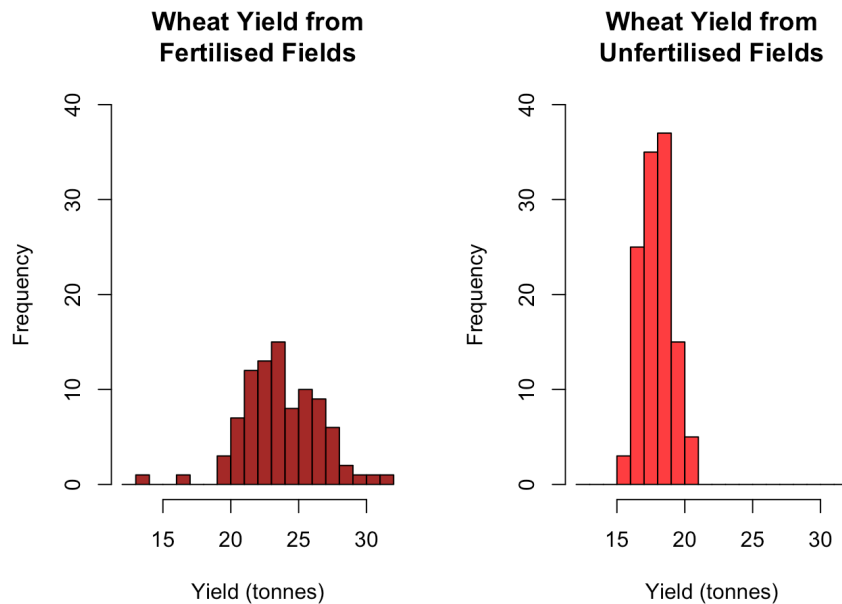


Figure 3: Histograms of wheat yields (in tonnes) from fields which are fertilised and fields which are unfertilised.

QQ-plots of the wheat yields from all fertilised and unfertilised fields are shown in Figure 4. These suggest that both sets of yields approximately follow a normal distribution.

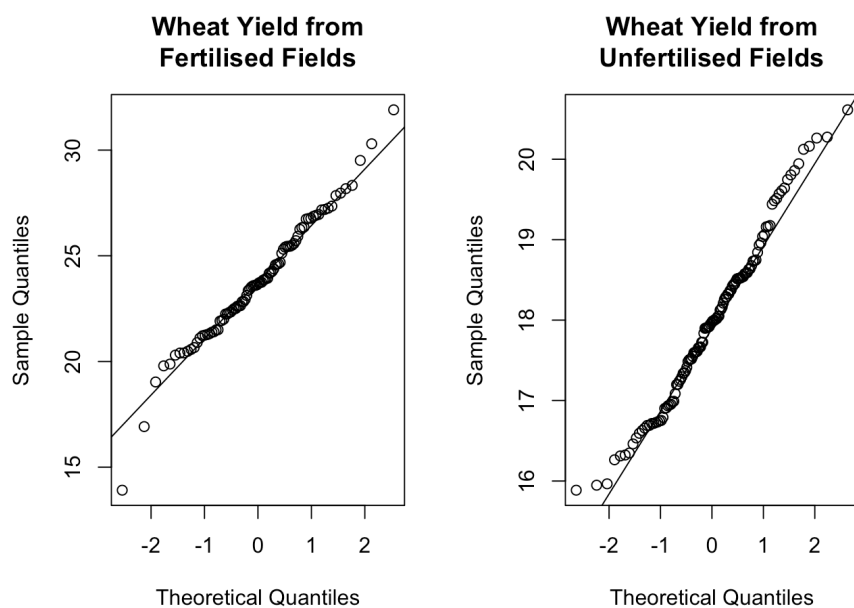


Figure 4: QQ-plots of wheat yields (in tonnes) from fields which are fertilised and fields which are unfertilised.

Statistical Analysis

To answer whether there is a difference between the mean yields of potatoes from fields that were fertilised and from fields that were left unfertilised, a 95% confidence interval for the difference in means from the two populations is used. This is calculated assuming that both populations of potato yield from fertilised and unfertilised fields follow normal distributions which have unknown but equal variances.

The 95% confidence interval for the difference between the mean yields of potatoes from fields that were fertilised and from fields that were left unfertilised is $[-0.9696, 1.2769]$. This interval contains the value zero, so there is no statistically significant evidence at the 5% significance level to suggest the mean yields are different.

A 95% confidence interval for the difference between the population mean yields of wheat from fields that were fertilised and from fields that were unfertilised is used to determine if there is a statistically significant difference between these two values. This is calculated assuming that both populations of wheat yield from fertilised and unfertilised fields follow a normal distribution which have unknown and unequal variances.

The 95% confidence interval for the difference between the mean yields of wheat from fields that were fertilised and from fields that were unfertilised is $[5.1910, 6.4484]$. There is statistically significant evidence, at the 5% significance level, that there is a difference between the mean yields of wheat, and it can be said with 95% confidence that the true difference between these population means is between 5.1910 tonnes and 6.4484 tonnes.

Conclusion

In this analysis, exploratory analysis shows that the samples of potato yields from fertilised and unfertilised fields have similar means and standard deviations (see Table 1 and Figure 1). A 95% confidence for the difference between these population mean yields further suggests this equality of means as there is no statistically significant evidence of a difference between the mean yields of potatoes from fields that were fertilised and from fields that were left unfertilised.

Exploratory analysis also shows that there is a large difference in the sample mean yields of wheat from fertilised fields and unfertilised fields and that these two groups have

different standard deviations (see Table 1 and Figure 3). A 95% confidence interval for the difference between these population mean yields further suggests the inequality of these means as there is statistically significant evidence of a difference between the mean yields of wheat from fields that were fertilised and fields that were left unfertilised.

When analysing whether there is a difference between the mean yields of potatoes from the two types of fields, the assumption of equal variances in the two populations may affect the conclusions reached. Another confidence interval assuming unequal variances in the two populations of potato yields could be calculated in future analysis and the conclusions reached compared to those made here under the assumption of equal variances.