The impact of lime and fertiliser on cotton in conservation farming basins

Introduction

The purpose of the trial is to find the impact of lime and fertiliser on cotton in conservation farming basins in the region IIa agro-ecological zone.

Data

Table 1 shows the distribution of yields from the Dunavant's cotton trials run by the Conservation Farming Unit. The data are from 43 on-farm trials of a 2^2 factorial design in Western, Southern and Central regions of Zambia. The average yield from all the trial treatments was 1,299kg ha^{-1} with a standard deviation of 602kg. The median was 1,264 kg ha^{-1}, which suggests a fairly normal distribution. The lowest yielding treatment was 158 kg ha^{-1} and the highest 2,718 kg ha^{-1}.

Table 1 shows the distribution of yields from the Dunavant's cotton trials run by the Conservation Farming Unit.

Dunavant cotton trial						
	n	**Mean**	**Median**	**StDev**	**Min**	**Max**
Cotton yield	170	1,299.1kg	1,264.0kg	601.7kg	158.0kg	2,717.6kg

Table 2 shows the distributions of cotton yields for the different treatments. The four treatments are 1) without lime and fertiliser, 2) with lime and without fertiliser, 3) with fertiliser but without lime, and 4) with both lime and fertiliser. The treatments fail to accept the null hypothesis that the means are from the same population. The mean yield for cotton without lime and fertiliser is 1,121kg ha^{-1} with a standard deviation of 555kg, for cotton with lime only 1,133 kg ha^{-1} with a standard deviation 594kg, for cotton with fertiliser only 1,421 kg ha^{-1} with a standard deviation of 578kg, and with both lime and fertiliser, 1,529 kg ha^{-1} with a standard deviationof 592kg.

Table 2 shows the distributions of cotton yields for the different treatments.

```
ANALYSIS OF VARIANCE ON CotYield
SOURCE     DF        SS         MS         F        p
C2          3   5382781    1794260      5.34    0.002
ERROR     166  55797552     336130
TOTAL     169  61180336

                                    INDIVIDUAL 95% CI'S FOR MEAN
                                    BASED ON POOLED STDEV
 LEVEL      N      MEAN     STDEV  ---+---------+---------+---------+---
     1     43    1121.4     554.8   (------*------)
     2     43    1133.2     593.6   (------*------)
     3     42    1421.1     577.9                (------*------)
     4     42    1528.8     592.1                    (------*------)
                                    ---+---------+---------+---------+---
POOLED STDEV =    579.8             1000      1250      1500      1750
```

Table 3 shows the distribution of cotton yields with fertiliser. The null hypothesis that there is no difference between yields with and without fertiliser fails to be accepted. The average yields without

fertiliser are 1,127kg ha^{-1} with a standard deviation of 571kg, and with fertiliser 1,475kg ha^{-1} with a standard deviation of 584kg.

Table 3 shows the distribution of cotton yields with fertiliser.

```
ANALYSIS OF VARIANCE ON CotYield
SOURCE     DF        SS        MS        F        p
Fert        1   5136038   5136038    15.40    0.000
ERROR     168  56044296    333597
TOTAL     169  61180336
                                  INDIVIDUAL 95% CI'S FOR MEAN
                                  BASED ON POOLED STDEV
 LEVEL      N      MEAN     STDEV  ----------+---------+---------+------
    -1     86    1127.3     571.2  (-----*------)
     1     84    1475.0     584.1                   (-----*-----)
                                  ----------+---------+---------+------
POOLED STDEV =    577.6                 1200      1400      1600
```

Table 4 shows the distributions from cotton yields with and without lime. The lime results are not so good, failing to reject the null hypothesis that the means are from the same population. The mean yield without lime is 1,270 kg ha^{-1} with a standard deviation 583kg, and 1,329 kg ha^{-1} with a standard deviation of 622kg with lime.

Table 4 shows the distributions from cotton yields with and without lime.

```
ANALYSIS OF VARIANCE ON CotYield
SOURCE     DF        SS        MS        F        p
Lime        1    148871    148871     0.41    0.523
ERROR     168  61031464    363283
TOTAL     169  61180336
                                  INDIVIDUAL 95% CI'S FOR MEAN
                                  BASED ON POOLED STDEV
 LEVEL      N      MEAN     STDEV  ------+---------+---------+---------+
    -1     85    1269.5     582.8  (------------*------------)
     1     85    1328.7     622.0         (------------*------------)
                                  ------+---------+---------+---------+
POOLED STDEV =    602.7               1200      1300      1400      1500
```

Table 5 shows the cotton yields by Central, Western and Southern regions. The analysis of variance suggests there is no difference in mean yields between them. The average yield in Central region is 1,305 kg ha^{-1} with a standard deviation of 527kg from 32 treatments; in Western it is the highest at 1,393 kg ha^{-1} with a standard deviation of 613kg from 58 treatments; and in Southern the average yield is the lowest at 1,228 kg ha^{-1} with a standard deviation of 619kg from 80 treatments.

Table 5 shows the cotton yields by Central, Western and Southern regions.

```
ANALYSIS OF VARIANCE ON CotYield
SOURCE     DF         SS         MS         F         p
Regions     2     914259     457130      1.27     0.284
ERROR     167   60266076     360875
TOTAL     169   61180336

                                      INDIVIDUAL 95% CI'S FOR MEAN
                                      BASED ON POOLED STDEV
 LEVEL      N       MEAN      STDEV  -------+---------+---------+---------
    -1     32     1305.5      527.0  (-------------*-------------)
     0     58     1393.1      612.6            (----------*---------)
     1     80     1228.4      619.0  (--------*--------)
                                      -------+---------+---------+---------
POOLED STDEV =    600.7                  1200      1350      1500
```

Results

So, although fertiliser is seen to be effective at even at a simple level, the same does not hold for lime, and in all the cases so far, the variance explained is very small. Much of the variance in on-farm trials is caused by the different environmental conditions of each of the trials, and so the trial sites themselves account for most of the total sum of the squares and are important; instead of using the sites however, the site means are used as an index. The site mean is a covariate that explains as much variance as the sites. After the site mean, fertiliser is very significant with an F-statistic of 140.67. The implication is that fertiliser increases the adjusted cotton yield of 1,112kg ha-1 with a standard deviation of 22.47kg to 1,492kg ha-1 with a standard deviation of 22.74kg, an increase of 34 per cent. Lime is significant at a ten per cent level with an F-statistic of 3.43, which suggests that the adjusted mean rises from 1,272kg ha-1 to 1,332kg, a rise of 4.7 per cent. The interaction between lime and fertiliser is not important and nor are the interactions between lime and fertiliser and the site means. This implies that the yields do not diverge as yields increase, which means that fertiliser and lime will always increase years irrespective of farmer ability.

Table 6 shows the results from a general linear model.

```
F-test with denominator: Error
Denominator MS =  43384 with 163 degrees of freedom

Numerator       DF   Seq MS      F       P
sitemean         1 47668640  1E+03   0.000
Lime             1   148871   3.43   0.066
Fert             1  6102940 140.67   0.000
Lime*Fert        1    97871   2.26   0.135
Lime*sitemean    1    17450   0.40   0.527
Fert*sitemean    1    72938   1.68   0.197
```

Figure 1 shows the yields of cotton with and without lime. Although the analysis above shows that the use of lime significantly increases yield at a ten per cent level, if the cost of lime[1] is K50,000 per hectare, and farmers sell their cotton at K1,220 per kilogram at farm-gate, then farmers need an incremental yield of 41kilograms to cover the cost of the lime, so although lime increases the yield and covers the cost of lime, the difference seems marginal.

[1] 250kg of lime cost K200 per kilogram at the beginning of the 2002/3 season.

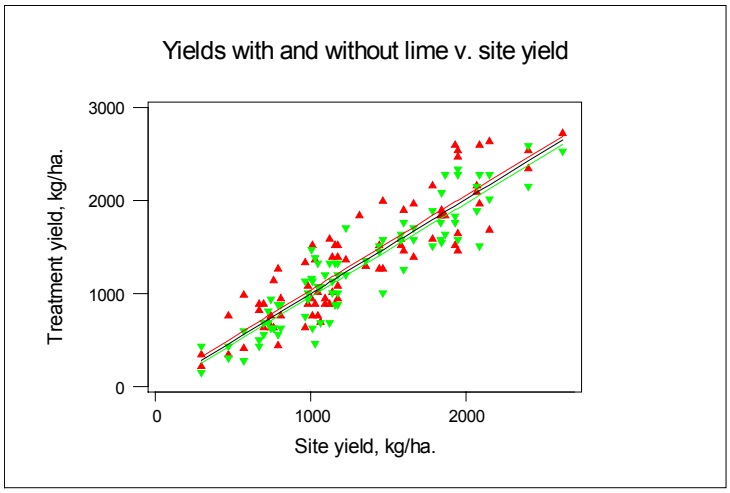

Figure 1 shows the yields of cotton with and without lime.

Figure 2 shows cotton yields with and without fertiliser. The use of fertiliser is less critical however, but if farmers spend K240,000 on fertiliser per hectare[2], then they need to produce at least 197 kilograms more cotton to pay for it at K1,220 per kilogram. In these trials, fertiliser always pays for itself.

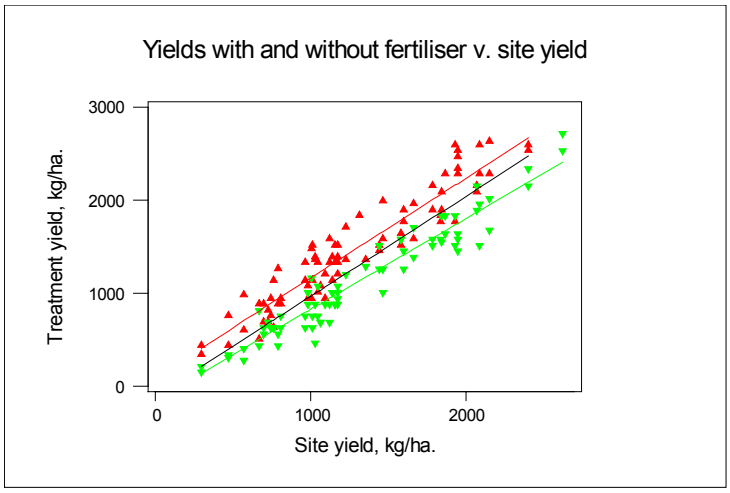

Figure 2 shows cotton yields with and without fertiliser.

Conclusions

1) Lime increases the yield of cotton in conservation farming basins in the region IIa agro-ecological zone by about 4.7 per cent, but after costs the benefits seem marginal.

[2] 200kg of Cotton Mix basal dressing per hectare cost K60,000 per bag at the beginning of the 2002/3 season.

2) Fertiliser increases the yield of cotton in conservation farming basins in the region IIa area by 34 per cent, and always covers the cost of fertiliser.

3) In both cases, the successful use of lime and fertiliser is not a function of farmer ability.