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A STUDY ON WHEN TO CONCLUDE A LONG TERM FERTILIZER TRIAL ON COCONUT YIELD

D. T. MATHES

Coconut Research Institute, Lunuwila, Sri Lanka

ABSTRACT

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Yield data obtained for twenty consecutive years from a fertilizer trial carried out at the Coconut Research Institute in Sri Lanka on a mature coconut plantation was subjected to an analysis with a view to ascertaining the relative influence of repeated application of fertilizer on coconut yield.

The inter-annual correlation coefficients between successive pairs of years showed that the correlations first increased, then reached a plateau, then increased again and finally ended up in an asymptote. From the eighth year onwards the inter-annual correlation between succeeding pairs of years remained stationary. The average correlation was 0.9351.

On the basis of these results, an eight to ten year period is considered sufficient to understand the full response to fertiliser in an experiment. After this period, it appears no useful purpose would be achieved.

INTRODUCTION

Many authors have discussed the analysis of data from experiments conducted simultaneously at a number of places and those conducted at some location for a number of years. (Cochran and Cox, 1950, Crowther and Cochran, 1941, Yates and Cochran, 1938; Snedecor and Cochran, 1967; Pearce 1953; Stevens, 1949).

The main aim of these authors had been to find out how best the long term experiments could be analysed using their methods. Some of these methods had been used to analyse long term fertilizer trials on coconut yield in Sri Lanka too. However, it appears that there is no published literature on any work done to determine a suitable period of time to conclude a fertilizer trial on coconut yield.

As much as analysing an experiment with the most appropriate analysis is very important it would also be important to decide when to conclude a fertilizer trial. An attempt is made in this paper to suggest a suitable period by using the inter-annual correlation coefficients between succeeding pairs of years.

MATERIALS AND METHODS

A fertilizer trial that was commenced in 1955 at Bandirippuwa Estate in Sri Lanka on a mature coconut plantation of about 30 years was the source from which yield data (kg copra) were obtained for this study.

The experimental layout was an N.P.K. factorial design with three levels each. The second order interaction was confounded with the block effects. The total of six picks, picked at two monthly intervals within a year, was taken as the total yield for that year.

The yield data obtained for a period of 20 years are under consideration in this paper. The years will be named as MI, MII and so on up to MXX for the whole 20 year period.

A point of interest was to find out whether the fertilizer effects get stabilised with the lapse of years and if so after which year. This was attempted by calculating inter-annual correlations for the twenty year period.

RESULTS

Inter-annual Correlations

For the whole 20 year period the inter-annual correlation coefficients between successive pairs of years were calculated and the period was then divided into first 10 year period and 2nd 10 year period for the purpose of discussion.

(a) **First 10 year period**

The correlation coefficients presented in Table 1 are all significant.

It would be interesting to note that the magnitude of the correlation coefficients between consecutive years increase with the age of the experiment. Other than the low correlation coefficient (r = 0.3700**) between MII and MIII there appears to be a significant pattern of the correlation coefficients. This low correlation between MII and MIII may be attributed to the fact that a rapid response to fertilizer is taking place during this period (Loganathan P. 1978)

The inter-annual correlation coefficients increase up to the fourth year and there is hardly any change for the next three years, after which the correlations increase and then flattens out. It appears that the correlations increase in two clear phases. First they increase, then reach a plateau and increase again and end up in an asymptote.

A test was then carried out to find out the significant difference between two correlations. Table 2 shows the 't' values for testing the significant difference between two correlations.

Table 2. *'t' values for comparison between correlation coefficients*

Comparison	*'t' Value*
0.6133 vs 0.7078	0.85 ns
0 7078 vs 0.8490	2.06 *
0 8490 vs 0.8597	0.19 ns
0.8597 vs 0.8180	0.66 ns
0.8180 vs 0.9435	2.95 **
0.8597 vs 0.9435	2.30 *
0.9435 vs 0.9355	0.33 ns

* Sig at P = 0.05
** Sig at P = 0.01

Table 1. *Inter-annual correlation coefficients of succeeding pair of years (MI to MX)*

Year	*M II*	*M III*	*M IV*	*M V*	*M VI*	*M VII*	*M VIII*	*M IX*	*M X*
M I	0.6133***								
M II		0.3700***							
M III			0.7078***						
M IV				0.8490***					
M V					0.8597***				
M VI						0.8180***			
M VII							0.9435***		
M VIII								0.9355***	
M IX									0.9573***

*** Significant at $p = 0.001$

Table 3. *Inter-annual correlation coefficients of succeeding pair of years. (M XI to M XX)*

Year	*M XI*	*M XII*	*M XIII*	*M XIV*	*M XV*	*M XVI*	*M XVII*	*M XVIII*	*M XIX*	*M XX*
M X	0.9341***									
M XI		0.9181***								
M XII			0.9389***							
M XIII				0.9103***						
M XIV					0.9312***					
M XV						0.9698 ***				
M XVI							0.9085***			
M XVII								0.9481***		
M XVIII									0.9242***	
M XIX										0.9182***

*** Significant at p = 0.001

The pair of correlations 0.6133 and 0.7078 does not show a significant differennce between them. However, in the broad sense it could be reasonable to suggest an increasing correlation up to the fourth year, since the next pair of correlation coefficients (0.7078 and 0.8490) is significantly different. No significant differences among the correlations, 0.8490 0.8597 and 0.8180 suggest the first plateau. The average correlation coefficient during the plateau period is 0.8545. This calculation is possible since the three correlation coefficients are homogeneous $x^2 = 0.465$ with 2 d.f.).

The presence of significant difference between 0.8597 and 0.9435, 0.8180 and 0.9435 and the absence of significant difference between the rest of the correlations strongly suggest that after the first plateau there is an increase in the correlations and thereafter a second plateau is reached. The last three correlations in the second plateau too show a homogeneity ($x^2 = 1.33$ with 2 d.f.) among themselves. The average correlation coefficient is 0.9329.

(b) Second 10 year period

Further evidence, that once the second plateau is reached the correlations end up in an asymptote, will help one to draw conclusions or make suggestions as to when a fertilizer trial has to be concluded.

Table 3 shows the inter-annual correlation coefficients between succeeding pairs of years.

The inter-annual correlation coefficients among the succeeding pairs of years are all significant and above 0.9000. All these correlation coefficients are homogeneous ($x^2 = 12.64$ with 8 d.f.) having an average value of 0.9351, and the correlations among the pairs of years fluctuate slightly about this mean of 0.9351. In the broad sense the correlation coefficient could be regarded as identical in magnitude.

DISCUSSION

The beneficial effect of application of fertilizer on coconut yield is now established under different soil conditions in Sri Lanka. Many questions appear to have been answered on the objectives of fertilizer trials conducted on coconut yield and a series of papers have been published on such subjects as suitable combinations of major nutrients, expected yield increase under such combinations and economic aspects of fertilizer application (Abeywardena, 1963; Abeywardena, 1965; Abeywardena, 1975; Loganathan *et al.*, 1975; Salgado, 1946).

Once the objectives of such an experiment have been achieved and no additional gain is obtained, there may be no useful purpose in continuing the experiment after a certain period of time. An attempt is made in this paper to suggest a suitable period to carry on a fertilizer trial.

In the case of the coconut palm there is a time lag between application of fertilizer and the benefit gained by way of increased nut production. Hence the first step, before thinking of discontinuing an experiment, would be to study the build up of response due to continued application of fertilizer.

The first step one could think of in such a study would be to see the yield pattern over the years for differently treated plots. However, such an approach will end up without any conclusion, because of the fluctuations one would observe over the years. This is due to the established fact that the weather plays a prominent role on the yield of coconut, whether fertilized or not (Abeywardena, 1966; Abeywardena, 1971; Abeywardena 1972; Abeywardena and Mathes, 1971).

If the above method fails one would try the same procedure after adjusting for weather effects. The efficiency of such a method will depend on the extent of adjustments one could make.

Abeywardena (1975) has done a study on the build up of response due to continued application of fertilizer on coconut yield. In his study he has used only the treated plot which gave the optimum yield, probably because his study was directed towards an economic evaluation. He has adjusted the yield for weather effects and the adjustment is only about 41% efficient.

The above methods, if used for all the treated plots, would yield some idea about the build up of response with the years. However, the author feels that such methods will be very laborious and not very satisfactory on deciding when to stop the fertilizer trial conducted on coconut yield which, apparently, is a very important decision.

In calculating the inter-annual correlation coefficients between successive pairs of years and since the whole experiment is taken as one unit, one can ignore the effect due to weather since the weather affects all the treated plots equally alike.

The correlation coefficient between MI and MII ($r = 0.6133$) increased upto 0.8490 during the first four years. This increase in correlation coefficient between years suggests that the relationship between the years is getting closer. For the next three years the correlation remained stationary with an average value of 0.8545. This may mean that there was no fertilizer effects taking place on the yield of coconut.

After this three year period the correlation increased up to 0.9435 and remained stationary for the next 12 or 13 years with an average value of 0.9351. This indicates that the relationship between successive pairs of years had become very high after about the 8th year.

The results thus obtained suggest that there are two clearly defined phases of yield response due to application of fertilizer, *viz.*, first an increase then a plateau and an increase again and ending up in an asymptote. This may indicate that fertilizer effects have become more or less stabilised somewhere between the 8th and the 10th year.

The average correlation coefficient of 0.9351 would have attained a rather higher values possibly very much closer to unity if not for a possible interaction between the yield and it, responsiveness to a particular stimulus due to the effect of weather. However, this interaction appears to be rather low and could be ignored for the purpose of this study.

Hence by comparing the pattern of the inter-annual correlation coefficients over the 20 year period considered, it may be concluded that there is no useful gain achieved by continuing a fertilizer trial on mature palms beyond eight years or so.

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REFERENCES

Abeywardena, V. (1963). Economics of fertilizer use. *Trop. Agric.*, **119**, 183–202.

Abeywardena, V. (1965). The Economic optimum in the rate of fertilizer application. *Ceylon Coconut Plrs. Rev.*, **4**, 1–11.

Abeywardena, V. (1966). Crop fluctuations in coconut. *Ceylon Coconut Plrs. Rev.*, **4**, 47–50.

Abeywardena, V. (1968). Forecasting coconut crops using rainfall data – a preliminary study. *Ceylon Cocon. Q.*, **19**, 161–176.

Abeywardena, V. (1971). Yield variations in cocount, *Ceylon Cocon. Q.*, **22**, 97–103.

Abeywardena, V. and Mathes, D. T. (1971). Crop losses in coconut through button shedding and immature nutfall. *Ceylon Cocon. Plrs. Rev.*, **6**, 97–106.

Abeywardena, V. (1972). An interim production function to forecast coconut crops in Ceylon using fertilizer consumption and rainfall data. Paper prepared for the use of the Coconut Research Board.

Abeywardena, V. (1975). Economics of the response of coconut to fertilizer application. *Ceylon Cocon. Q.*, **26**, 77–85.

Cochran, W. G. and Cox, G. M. (1950). *Experimental designs.* 545 p. 2nd. ed, New York, John Willey and Sons, Inc., New York, London, Sydney.

Crowther, F. and Cochran, W. G. (1941). Rotation experiment with cotton in the Sudan Gezira. *Jour. Agri. Sci.*, **32**, 390–405.

Loganathan, P., Balakrishnamurti, T. S. and Mathes, D. T. (1975). Response of coconut to N, P, K fertilizer on a lateritic gravel soil. Paper read at the Sri Lanka Association for the Advancement of Science sessions, 1975.

Loganathan, P. Personal communication (1978).

Pearce, S. C. (1953). *Field experimentation with fruit Trees and other perennial plants.* 131 p. Technical Communication No : 23 of the Commonwealth Bureau of Horticulture and Plantation Crops. East Malling, Maidston, Kent, England.

Salgado, M. L. M. (1946). Recent studies on the manuring of coconuts in Ceylon. *The Tropical Agriculturist.*, **102**, 206–218.

Snedecor, G. M. and Cochran, W. G. (1967). *Statistical methods* 593 p. 6th ed., The Iowa State University Press. Ames, Iowa, U.S.A.

Stevens, W. L. (1949). Analise estatistica do ensuio de variedades de cafel. *Bragantia*, **9**, 103–23

Yates, F. and Cochran, W. G. (1938). The analysis of groups of experiments. *Jour. Agri. Sci.*, **26**, 556–580.