

PRE-HARVEST FORECASTING OF CASHEW YIELD BASED ON BIOMETRICAL CHARACTERS

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ABSTRACT

A study conducted for three years during 1978-81 to standardize a technique for forecasting cashew yield based on seven biometrical characters recorded at weekly intervals, revealed that yield can be forecast with reasonable precision ($R^2=0.64$) by a single spot observation made during the peak flowering period (February-March). The number of variables could be brought down to three viz. the number of nuts on the tree, condition of flowering (graded 0 to 5), and canopy area, without substantially affecting the accuracy of the estimate ($R^2=0.61$).

INTRODUCTION

Pre-harvest forecasting of agricultural crops is essential in research and development programmes. In annual crops like paddy, wheat, cotton, jowar, and jute, methods have been developed for pre-harvested forecasting. Singh, Jha and Aneja (1979) have discussed various forecasting methodologies and reviewed the various forecasting systems in relation to annuals, but there is very little work on perennial crops. Vernon (1971) estimated the annual yield of cocoa from sample picks. Arul Raj, Narasimhayya, Haveri and Rajasulochana (1979) estimated coconut yield based on snap observations. George and Vijaya Kumar (1979) developed a forecasting method for cashew based on sample observations taken on different occasions during the flowering period.

The harvest of cashew extends to about 4 months and it is rather difficult to collect the yield data from individual trees. The present study was conducted to identify suitable biometrical characters, to find out the optimum period of sampling and to standardize a technique of forecasting cashew yield based on, if possible, a single observation.

CPCRI contribution No. 245.

MATERIALS AND METHODS

Forty cashew trees in the 15-20 years age group were selected at random each year, for three years beginning from 1979, from the cashew plantation of Plantation Corporation of Kerala at Muliyar. Observations were recorded on the number of shoots (x_1), number of panicles (x_2) and number of nuts at all stages of maturity (x_3) counted from $\frac{1}{2}\text{m} \times \frac{1}{2}\text{m}$ dimension on the canopy of the tree taken from four directions, north, east, south and west. The total number of nuts in the tree (x_4) was counted and the condition of flowering (x_5) recorded at weekly intervals. The first round of observations for the initial year was recorded during the last week of February (when about 50% of the trees had nuts in the peanut stage) and for the next year (1980) during the middle of February. During the last year (1981) the first round of observations were recorded during the last week of January in order to study the early stages of flowering also. The observations were continued for 14 weeks during the first year, 12 weeks in second year, and 8 weeks in the third year. The canopy area (x_7) was worked out. The total yield of nuts (Y) in the daily harvest and average weight per nut (x_6) was determined. Multiple regression equation of the form $Y = b_0 + \sum b_i x_i$ using the above observations were worked out for each week to forecast the final yield (Y). The regression equations were tested for homogeneity, and combined estimates were arrived at for each year. The regressions were further pooled over the years after eliminating the year effect to get a forecasting equation for any year.

RESULTS AND DISCUSSION

Table 1 gives the coefficients of determination for the multiple regression equations based on the 7 biometrical characters. During 1979, first round of observations gave the maximum coefficient of determination, while in the second year, the 3rd, 4th and 5th rounds gave very high R^2 (0.92 to 0.94), and during 1982, higher R^2 values were obtained for 6th, 7th and 8th rounds (0.84 to 0.89). When tested for homogeneity of regressions over the rounds, 1st, 2nd and 3rd for 1979, 3rd, 4th and 5th rounds during 1980 and 5th, 6th, 7th during 1981, were found to be homogeneous. It was seen that these rounds in each year corresponded to the peak flowering phase with large number of nuts in the peanut stage, thereby showing that

Table 1. R^2 values for the regression equation to predict total yield using seven biometrical characters

Rounds/Weeks	1979	1980	1981
1	0.55**	0.82**	0.65**
2	0.42**	0.91**	0.60**
3	0.44**	0.92**	0.77**
4	0.47**	0.94**	0.65**
5	0.38*	0.94**	0.75**
6	0.46**	0.81**	0.84**
7	0.38**	0.87**	0.89**
8	0.39*	0.68**	0.89**
9	0.40*	0.59**	
10	0.41*	0.62**	
11	0.45**	0.38*	
12	0.39*	0.49**	

*Significant at 5% level; **significant at 1% level.

this is the correct stage for recording observations to predict the yield.

Table 2 gives the coefficients of determination obtained by combining 3 rounds of observations within each year and pooled estimate over the years eliminating year effect for all the 7 characters together, as well as the three important characters namely, number of nuts (x_4), condition of flowering (x_5), and canopy area (x_7), and then taking number of nuts (x_4), and canopy area (x_7) only.

Table 2. R^2 values for regression equation to predict the total yield by combining rounds and years.

Years	With all the 7 characters	With 3 characters x_4 , x_5 and x_7	With 2 characters x_4 and x_7
1979 (1, 2 and 3)	0.43	0.36	0.20
1980 (3, 4 and 5)	0.88**	0.84**	0.84**
1981 (5, 6 and 7)	0.81**	0.80**	0.79**
Pooled for 3 years	0.64**	0.61**	0.59**

**Significant at 1% level.

The contribution from characters other than x_4 , x_5 and x_7 were found to be negligible as was evident on comparing the respective R^2 values. The trend was same in all the years. The R^2 values were low in 1979 and high in 1980 and 1981. The year 1979 was a lean year for production because of severe tea-mosquito attack which may be the possible reason for low R^2 for that year. The regression equation obtained for forecasting the total yield (in kg) of cashew obtained by pooling the combined regressions for the three years, eliminating the year effects was as follows:

$$Y = -2.401 - 0.002x_1 + 0.013x_2 + 0.015x_3 + 0.010x_4 \\ (0.0045) \quad (0.0071) \quad (0.0111) \quad (0.0008) \\ + 0.228x_5 + 0.204x_6 + 0.007x_7 \quad (R^2 = 0.64) \\ (0.0728) \quad (0.0485) \quad (0.0020)$$

It is seen that the coefficients for the characters, number of shoots (x_1), number of panicles (x_2), and number of nuts (x_3) per unit area were not significant. Average number of nuts can be obtained only after harvesting at least a few nuts from the trees and as such this character cannot be observed in the pre-harvest stage. It is seen from Table 2 that the contribution of these four characters is not substantial (R^2 is reduced from 0.64 to 0.61). Hence, the prediction equation is reduced to:

$$Y = 1.459 + 0.0094x_4 + 0.3314x_5 + 0.0082x_7 \quad (R^2 = 0.61), \\ (0.0005) \quad (0.0058) \quad (0.0019)$$

where x_4 is the number of nuts on the tree, x_5 is the condition of flowering graded from 0 to 5 depending upon the flowering at any time during the peak flowering period of about a month, x_7 the canopy area (in m^2), and Y is the estimated yield in kg. It shows that by taking a single spot observation on these three characters at anytime during the peak flowering period, the yield can be forecast with reasonably good precision ($R^2 = 0.61$). In cases where high personal bias is suspected in recording the condition of flowering (x_5) the same can be deleted, and the prediction equation reduced to: $Y = -0.43 + 0.01x_4 + 0.0075x_7$, without much loss of precision (0.0005) (0.002)

($R^2=0.59$). Considering the cumbersome nature of the procedure for finding out the yield per tree based on daily harvest of nuts for a period of 3-4 months, the above result based on a single spot-observation is very much relevant. By this method, the estimate of the final yield can be made 4-5 months before the completion of harvest. This study also specifies the period of recording observations for forecasting cashew yield as the peak flowering phase, and only one round of observations is needed for the purpose. Thus, this is an improvement over our previous study (George and Vijaya Kumar, 1979).

ACKNOWLEDGEMENT

The authors are grateful to the Managing Director, General Manager (Cashew), and Superintendent, Cashew Plantation, Muliyar Division of the Plantation Corporation of Kerala for giving all the facilities for conducting this trial.

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DISCUSSION

- R. C. MANDAL: Branching habit of cashew is extremely variable. Hence the prediction may not hold good.
- M. V. GEORGE: As the canopy area is directly correlated with branching habit, the prediction will hold good.
- C. RAMACHANDRAN: Can we use this formula for forecasting future yield from a tree?
- M. V. GEORGE: No. This technique is applicable only for the current season.