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# FORECASTING OF CASHEW YIELD FROM PLANTATIONS

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ABSTRACT

A method to forecast the cashew yield from large plantations based on biometrical characters/yield attributes from small sample of trees was attempted. For this purpose, data collected during 1982 and 1983 from Cashew Plantations at Muliyar and Perla and during 1982, 1983 and 1984 from Periya belonging to the Plantation Corporation of Kerala were made use of. A double sampling procedure was used to get a ratio estimate by which a small sample (n) is used for detailed observations and a large sample (n')is used for recording an easily observable character. In gardens ranging between 100 to 300 cashew trees a maximum of 200 trees for recording the character condition of flowering graded 0 to 5 and a sub sample of 20 trees for recording the canopy area and estimated number of nuts at all stages of maturity are sufficient to give an yield estimate of the garden with 20 per cent deviation at 5% level of significance. Double sampling was relatively two to three times efficient than simple random sampling. This methodology can be safely adopted to forecast the total yield from large plantations by subdividing the area into blocks of 150 to 300 trees considering the natural boundaries and selecting a small sample of such blocks, according to any suitable sampling design.

## INTRODUCTION

The harvest of cashew extends to 3-4 months and it is rather difficult to collect the yield data from a large number of trees over a large area. George and Vijayakumar (1979) developed a forecasting method for estimating cashew yield from any tree based on sample observations taken on different occasions during the flowering phase. George *et al* (1982) observed that the yield from any cashew tree can be forecast by a single snap observation made during the peak flowering period (Feb-March). The present study was intended to refine the forecasting methodolgy for individual trees and to utilize this procedure to estimate the total yield from large plantations/estates from only a small sample of trees.

## MATERIAL AND METHODS

A study was carried out for three years during 1982-84 at three centres viz., Periya, Perla and Muliyar cashew estates in Kasaragod District belonging to the Plantation Corporation of Kerala. Observations on the canopy area (Mohapatra *et al* 1973), condition of flowering (graded 0 to 5) and the estimated number of nuts at all stages of maturity were collected from all the trees in blocks of 314 trees

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Table I. *Correlation coefficients of biometrical characters with Yield in the three locations*

| Characters | Perla | | Muliyar | | Periya | | |
|---|---|---|---|---|---|---|---|
| | 1982 (145) | 1983 (138) | 1982 (112) | 1983 (106) | 1982 (305) | 1983 (286) | 1984 (292) |
| Canopy Area | 0.64** | 0.41** | 0.58** | 0.62** | 0.29** | 0.29** | 0.40** |
| Est.no.of nuts | 0.72** | 0.67** | 0.75** | 0.73** | 0.79** | 0.71** | 0.73** |
| Cond. of flowering | 0.81** | 0.82** | 0.75** | 0.64** | 0.79** | 0.83** | 0.81** |

Figures in the parenthesis give the number of trees considered for the analysis.

from Periya, 146 trees from Perla and 114 trees from Muliyar during the peak flowering phase (Feb-March). The yield data from all these trees were collected by daily harvest and average weight of nuts was worked out. The above observations were collected for three years from Periya and two years each from Perla and Muliyar. The correlations between these biometrical characters and yield were

Table II. *Multiple regression equations for forecasting cashew yield based on biometrical characters*

| Centre | Year | b0 | Canopy area b1 | Estimated No. of nuts b2 | Condition of flowering b3 | $R^2$ |
|---|---|---|---|---|---|---|
| Muliyar | 1982 | –2.441 | 0.028** | 0.007** | 0.763** | 0.74** |
| | | | (0.005) | (0.001) | (0.149) | |
| | 1983 | –4.282 | 0.050** | 0.012** | 0.851** | 0.71** |
| | | | (0.007) | (0.002) | (0.215) | |
| Pooled over years (Eliminating year effect) | | –3.275 | 0.039** | 0.008** | 0.795** | 0.69** |
| | | | (0.005) | (0.001) | (0.135) | |
| Perla | 1982 | –1.327 | 0.020** | 0.006** | 0.615** | 0.81** |
| | | | (0.003) | (0.001) | (0.063) | |
| | 1983 | –0.980 | 0.009** | 0.005** | 0.891** | 0.75** |
| | | | (0.003) | (0.001) | (0.079) | |
| Pooled over years (Eliniating year effect) | | –1.089 | 0.014** | 0.005** | 0.751** | 0.77** |
| | | | (0.002) | (0.001) | (0.050) | |
| Periya | 1982 | –0.894 | 0.006** | 0.007** | 0.730** | 0.76** |
| | | | (0.003) | (0.001) | (0.059) | |
| | 1983 | –0.417 | 0.003 | 0.008** | 0.646** | 0.75** |
| | | | (0.002) | (0.001) | (0.040) | |
| | 1984 | –2.417 | 0.020** | 0.009** | 0.985** | 0.75** |
| | | | (0.004) | (0.001) | (0.075) | |
| Pooled over years (Eliminating year effect) | | –1.217 | 0.010** | 0.008** | 0.790** | 0.73** |
| | | | (0.002) | (0.001) | (0.035) | |
| Pooled over the Locations | | –1.644 | 0.017** | 0.008** | (0.775)** | 0.70** |
| | | | (0.001) | (0.0004) | (0.033) | |

Figures in the parenthesis are the S.E.'s

worked out centre-wise and year wise (Table I).

Based on the individual tree observations on the canopy area, estimated number of nuts and condition of flowering, regression equations were worked out to forecast yield for each location after eliminating the year effect and then the over all regression equation eliminating the location effect (Table II).

In order to estimate the minimum number of sample trees required to estimate the population (garden) mean for a given cost wih minimum variance, a double sampling procedure was used to get a ratio estimate by which a small sample (n) is used for detailed observations and a large number (n') is used for recording the easily observable character viz., condition of flowering. The cost ratio used was 1:30 where 1 is the cost (i.e. time in minutes) for recording the condition of flowering in one tree and 30 is the cost (time in minutes) for recording the detailed observations. The estimates of mean, variance and relative effeciency were worked out as per Sukhatme & Sukhatme (1977) and as modified by Balakrishnan and Jose (1985). Estimates of yield (Y) was made using the formula $Y = N. \bar{Y}n. \frac{\bar{x}n'}{\bar{x}n}$ where $\bar{Y}n$ is the mean yield of n trees $\bar{x}n$ is the mean of the auxiliary variable (condition of flowering) for n trees, $\bar{x}n'$ is the mean of the auxiliary variable (condition of flowering) for n' trees and N is the total number of trees flowered in that block (garden). The relative efficiency of the double sampling procedure was compared with simple random sample (Table IV).

## RESULTS AND DISCUSSION

The correlation coefficients of canopy area, estimated number of nuts and condition of flowering with yield showed that all these three characters were highly corelated with yield (Table I), confirming the results obtained by George *et al* (1982). Multiple regression equations for forecasting the individual tree yields based on the above characters for the different years and locations, as well as the pooled regression values eliminating the year effect and the over all regression were given in Table II. It can be seen that the estimates were all relatively precise ($R^2 > 70\%$) using the prediction equation

$$Y = -1.644 + 0.017\ x_1 + 0.008\ x_2 + 0.775\ x_3$$
$$(0.001) \quad (.0004) \quad (0.033)$$
$$(R^2 = 0.70)$$

where $x_1$, $x_2$ and $x_3$ are the observed values for the canopy area, estimated number of nuts and condition of flowering respectively for estimating the total yield (Y) in kg of that tree. This equation is a refinement over the earlier one developed by George *et al* (1982) as in the present study a larger number of trees were sampled and observations repeated in three locations for a period of three years.

Further, the minimum number of trees required to be observed for the auxiliary variable viz. condition of flowering (n') and for the detailed observation (n) for estimating the population mean with a deviation of 20% at 5% level of significance is given in Table (III). From a block of 300 trees or less, a large number (n') of about 200 trees or the actual number of trees whichever is less are required for recording the easily observable character, viz. condition of flowering. But for recording detailed observations, only

Table III. *Number of sample trees required for detailed and auxiliary observations*

| Location | Year | No. of trees in the garden | No. of trees to be sampled | | |
|---|---|---|---|---|---|
| | | | For auxiliary observation | For detailed observation | |
| | | | | Number | Percentage |
| Muliyar | 1982 | 112 | 112 | 32 | 29 |
| | 1983 | 108 | 108 | 31 | 29 |
| Perla | 1982 | 145 | 145 | 19 | 13 |
| | 1983 | 138 | 138 | 14 | 10 |
| Peiya | 1982 | 305 | 211 | 21 | 7 |
| | 1983 | 286 | 214 | 14 | 5 |
| | 1984 | 292 | 163 | 13 | 4 |

about 20 trees (n) are required in a garden with normal heterogeneity, and about 30 trees when the trees are highly heterogeneous. Estimates obtained by double sampling ratio estimate were very close to the actual value, except for the year 1982 for Periya which may be due to sampling fluctuations (Table IV). The relative efficiency of double sampling ratio estimate was always more than 150% and in some cases up to 389% in comparison with simple random sampling procedure. This methodology, is highly useful in estimating the total yield from large plantations. The total plantations/ estates can be subdivided into blocks of 150-300 trees considering the natural boundaries. The required number of such blocks can be selected according to any sample survey design and the estimates of the total yield from those selected blocks can be worked out by observing a maximum of about 200 trees from each selected blocks for the condition of flowering and taking detailed observation from a sub sample of 20-30 trees and counting the total number of flowered trees (N). By this method it has become possible to take up large scale sample surveys and work out reliable estimates of cashew production scientifically.

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Table IV. *Efficiency of Double Sampling Ratio estimates*

| Location | Year | Estimated Average yield based on | | Actual average yield (whole popn.) | Efficiency of of double sampling compared to S.R.S. |
|---|---|---|---|---|---|
| | | S.R. sampling on n trees kg/tree | Double sampling kg/tree | kg/tree | |
| Muliyar | 1982 | 3.51 | 3.37 | 3.40 | 1.93 |
| | 1983 | 3.97 | 4.23 | 4.27 | 1.59 |
| Perla | 1982 | 1.92 | 1.82 | 1.84 | 3.34 |
| | 1983 | 3.23 | 2.60 | 2.52 | 2.65 |
| Periya | 1982 | 3.51 | 3.18 | 2.69 | 2.49 |
| | 1983 | 3.66 | 1.97 | 1.82 | 3.89 |
| | 1984 | 3.01 | 3.26 | 3.10 | 3.20 |

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