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Short Note

Unequal Probability Scheme for Fruit Count in a Guava Tree

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ABSTRACT

Data on fruit count corresponding to primary, secondary and tertiary branches of a randomly selected guava CV. Allahabad Safeda were recorded from the guava orchard of Horticultural Research Station, Birauli. The proposed sampling scheme in which the selection probabilities are based on length of braches between two forking points was compared with equal probability(PE), probability proportional to the number of branches(PPN), probability proportional to the cross sectional area (PPA) and probability proportional to volume(PPV)method of sampling and found to be more efficient.

Keywords: Unequal probability Guava fruit count.

INTRODUCTION

Fruits play important role in human nutrition, fruits like mango, guava and banana are important tropical fruits grown and consume in India (Singh *et al.,* 2005). Pomological experiments require counting of fruits on a tree and its respective branches. In addition to this the counting of fruits is also needed by the owner of the tree or the orchard for taking several decisions like auction of the orchard. Under these situation an accurate count of all the fruits is a time consuming job. A method of obtaining reasonably precise estimate of total fruits by sampling is of greater importance (Kumar *et al.,* 2014). Jessen (1955) described and compared their efficiencies on an orange tree by counting all the fruits on each branch of the tree. He tested three methods of selecting branch samples for estimating the total number of fruits.(1) equal probability(PE) for each branch, (2) probability proportional to the number of branches(PPN) into which each of these branches divide and (3) probability proportional to the cross sectional area(PPA) of the branch. The third sampling scheme was found to be more efficient while the first method was not practicable since it required some identification of all fruiting branches before the sampling can be carried out. Kumar *et al.* (1985) proposed probability sampling scheme for selecting limbs of the tree. They proposed two varying probability sampling schemes for selecting branches from terminal fruit bearing trees. The first was a new size measure number of feeder branches and the other was variation of Jessen's scheme. While discussing the results they suggested to take branch magnitude method or modified probability proportional to area method for obtaining a sample of fruits, leaves, shoots or flower clusters in two stages i.e. selecting first a branch by branch magnitude or modified probability proportional to area method and then the unit of interest from the selected branch by a suitable sampling scheme such as systematic sampling or equal probability sampling. Bharati and Prasad (2000) developed probability proportional to volume(PPV) method for selecting branches and to compared its efficiency with PE, PPN and PPA schemes.The present work attempts to determine the fruit count on the basis of probability proportional to the length of two forking point of the different branches of the tree.

Jessen (1955) described three sampling schemes for determining the fruit count on a tree *viz.* Equal probability scheme (PE), Probability proportional to number (PPN) and probability proportional to area (PPA). In PE scheme, all the terminal branches are numbered from 1 to N and a sample of size 'n' is drawn randomly. The mean of sample based on size n gives the estimate of fruit count on the tree. In PPN scheme, a sampling unit is selected by a random draw of branches at each consecutive forking points. In PPA scheme, the cross sectional area of a branch is used to determine the selection probability. This scheme provides at any fork that large branch will have greater chance of selection than a small branch. Bharati and Prasad (2000) used the probability proportional to volume scheme which was expected to provide in more reasonable manner that the voluminous branch would have a greater chance of selection. In case of voluminous branch, the volume of the branch was defined as cross sectional area multiplied by the length of a branch. For computing volume, the circumference of the branch was measured at three different positions of the entire length of the branch *i.e.,* at the beginning, at the middle and at the end of two forking points. But this approach requires measurement of the cross-sectional area of a branch and the distance of the two forking points and the computation of volume of branch. In case of probability proportional to the length of two forking points, there is no need to any further computation and the length can be easily measured even by a simple measuring scale of one feet.

Bharati and Prasad (2000) used the technique of computing volume of branch and their probabilities in following manner:

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The probabilities of sampling i^{th} branch at a given forking point

$$= C_i l_i / \sum_{i=1} C_i l_i \quad i = 1,2,\ldots\ldots,n.$$

Where C_i = circumference of i^{th}branch, li = length of i^{th} branch, n = number of branches.

The overall probability of sampling i^{th} branch = probability (i^{th} parent branch at first fork)* Prob. (i^{th} parent branch at second fork)*Prob. (i^{th} parent branch at n^{th} fork).

The estimates $\bar{x}$ = x/p; Where $\bar{x}$ = estimated number of fruits on the tree, x = actual number of fruits on a sample branch, p = overall probability of sampling branch.

In the present investigation the same data recorded on fruit count corresponding to primary, secondary and tertiary branches of randomly selected Guava tree (cv. Allahabad Safeda) from the orchard of Horticultural Research station Birauli were used. This data subjected to the computation of probability proportional of the length(PPL) of two forking points of the branch.

Estimates of variances for total fruit count as well as of per fruit and relative efficiencies of PE, PPN, PPA ,PPV and PPL were worked out. Estimates, of PE, PPN PPV and proposed scheme as well as the variances per fruit of estimates and relative efficiencies of methods are based on Jessen (1955).

The variances of estimates of total fruit counts, per fruit count and relative efficiencies are presented in table 1, table 2 and table 3, respectively.

Table1: Variances of estimates of total fruits on guava tree

Branch Description	PE	PPN	PPA	PPV	PPL
Primary	39204	39204	12641	2008	1356
Secondary	42712	42712	33998	7360	3350
Tertiary	76384	109412	72287	16657	62748

Table 1 and 2 indicate that the variances of estimates of total fruit count and per fruit count are least when PPL scheme is used for sampling. However PPV and PPL schemes resulted in almost same variances per fruit. It is also important to note that the selection of primary branches give least variances in comparison to secondary and tertiary branches in all the schemes of branch selection. The drastic reduction in variances is depicted in above tables as we go from PE to PPN to PPA to PPV. Whereas while going from PPV to PPL there is less reduction in the variances of estimates. The reasons are PPV is the function of PPA and PPL and the length of the two forking points, the cross-sectional area of the branch and the volume of the branch between two forking points are related to each other.

Table 2: Variances (in Millions) per fruit of estimates of total fruits on guava tree

Branch Description	PE	PPN	PPA	PPV	PPL
Primary	6.74	6.74	2.17	0.34	0.33
Secondary	3.67	3.67	2.92	0.63	0.63
Tertiary	2.63	3.67	2.49	0.57	0.58

The comparison of efficiencies of two branch sizes is equivalent to a comparison on the variances of two schemes when the total number of fruits counted for each scheme is same (Jessen,1955). The relative efficiencies of sampling schemes in comparison to smallest branch under PE schemes showed precise estimates of fruit count by taking large branch with PPV schemes. The least efficient schemes were PE and PPN with large branch under selection. The PE schemes showed considerable loss in efficiencies from smaller to larger branch size, but no trend was found in PPN, PPA, PPV and PPL schemes. The relative efficiency in comparison to tertiary branch under PE scheme, is highest for primary branch with PPV followed by PPL scheme. But for secondary and tertiary branches the relative efficiencies are more in PPL in comparison to PPV scheme.

Table 3: Relative efficiencies of sampling schemes (Tertiary branch under equal Probability scheme taken as 100)

Branch Description	PE	PPN	PPA	PPV	PPL
Primary	39	39	121	762	659
Secondary	72	72	90	415	534
Tertiary	100	70	106	459	587

The conclusions emerging from this investigation are (1) The PPL method of selecting branches at any given fork is more efficient, (2) The selection of primary branches through PPV method is most efficient

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