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Research on Objective Forecasts of Filbert Production

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Fruit and nut production in Oregon and other important producing areas is highly commercialized. Sales of many of these commodities are controlled by Federal marketing agreements to provide for orderly marketing of each year's crop. Officers of grower and processor organizations who are charged with the administration of the programs need accurate early-season forecasts of prospective production and quality of the product. Monthly production forecasts are published during the growing season by the Crop Reporting Service as part of the overall crop and livestock estimating program. However, the complexity of marketing problems faced by producers and their organizations has built up pressures for more detail and greater precision in such forecasts. This paper reports on a study being made on filberts in Oregon; the approach to the problem is typical of the approach now under study in several areas.

SOME NINE TREE fruit and nut crops are grown commercially in Oregon. Substantial numbers of growers belong to producer organizations. Many crops have multiple utilization patterns—the allocation of the total production in any given year to the various uses is a difficult and increasingly pressing problem. As a result, timely information during the growing season on the prospective volume and commercially pertinent characterstics of the crop is much in demand.

Monthly forecasts of prospective production by the Crop Reporting Service are based largely on growers' appraisals of crop conditions. Those appraisals are translated into production forecasts by means of a regression chart showing the relationship of reported data to final production in past years, with an allowance for time trend where necessary. A certain degree of judgment is interjected by the statistician in analyzing all of the information available to him at the time, and also by the Crop Reporting Board, which reviews his recommendations and is the ultimate authority in arriving at the forecast.

It has been argued that more specific observations on selected trees, such as early-season fruit counts, measurements of size of fruit, and counts of fruit dropping from the trees, should be more closely related to final production than is an overall appraisal of the condition of an entire orchard or grove.

It is not feasible to have such observations made by growers themselves because too many are unwilling to devote the necessary time to the work and, even if they were, there could be some doubt about the exactitude with which instructions for making the observations had been followed. This means that crews of trained samplers must be employed. The cost of such an operation is the largest single deterrent to having it adopted more generally. But needs for greater precision, particularly for highly specialized crops, are convincing an increasing number of interested groups that the higher cost is justified if appreciable improvements in the forecasts can be achieved.

For many years the citrus industry in California has successfully employed the "frame-count" procedure, supplemented by other pertinent observations, on sample trees in sample groves. To a lesser degree a similar approach has been tried in Florida. In recent years studies on the practicability of counting fruit on entire trees or on selected limbs of trees have been undertaken cooperatively by industry groups, State agencies, and the Crop Reporting Service, on citrus in Florida; on grapes, peaches, pears, lemons, and walnuts in California; and on filberts in Oregon.

Oregon Filbert Study

Forecasting production has been one of the many problems that the filbert industry has faced. The study described here was undertaken by the industry through the Filbert Control Board, the Oregon Filbert Commission, the Oregon Agricultural Experiment Station, and the Crop Reporting Service. It is a 3-year project and consists basically of an attempt to forecast production by measuring year-to-year changes in the set of nuts by making counts on sample limbs, together with

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observations on size and weight, defects such as blanks and worm damage, and amount of preharvest drop. Although measures of year-to-year change are expected to be the forecasting device that will yield greatest precision, observations are taken in a way that will also permit "direct expansion." Data are now available for one season only.

Sample Design

A listing of all plantings in the major producing area of Oregon and Washington is available from a survey of all producers of record who sold or delivered filberts to independent or cooperative handlers and processors in 1953 or 1954, or in both years. Each planting or "block" was identified by location (township), age of trees, and number of trees in each age group. The present study was restricted to the commercial producing counties in Oregon, plus Clark County, Washington, comprising about 97 percent of the United States crop. A sample of 300 orchard blocks was selected by applying a systematic sampling procedure with a random start after arranging orchards by location, age, and size. About 75 percent of all trees in the universe are Barcelona; other varieties are planted mostly as pollinizers for Barcelona.

After locating each sample orchard block, a sketch showing the number of rows of trees in each direction was prepared. In some instances the rows were counted by the samplers, but when growers were able to supply the information no actual tree count was made. A sample tree was drawn by selecting a sample location on the sketch with a table of random numbers; this gave every tree in the block an equal chance of selection. Pollinizer trees were accepted when they happened to be selected. Usually nuts from pollinizer trees are part of the production. On the average one is present for about every 7 or 8 of the primary variety. Two trees adjacent to the randomly-selected tree were also included in the sample. In 20 percent of the sample blocks a fourth tree was included; nuts were stripped from that tree after counting and counted again to measure the accuracy of the on-tree count. Altogether, 960 trees were in the sample.

As this study visualizes an ultimate operation in which nuts are counted on only part of each tree, it was necessary to devise a system for subdividing individual trees into sampling units, and a system for selecting such units for observation.

By nature the filbert tree is shrub-like. If left to itself it would grow in the form of an ever-expanding dense aggregate of individual shoots emanating from the ground. But by pruning it can be trained into the shape of a tree with about five main limbs which are fused into a trunk a short distance above ground. A well-kept filbert orchard has the appearance of rows of trees. To keep a tree in that condition continuous pruning of shoots that come up around the trunk is necessary.

Although most commercial plantings are in that condition, some orchards are in various stages of neglect. Depending upon price, the production from such orchards may become a part of the total variety. Some bushes never have been trained to assume the shape of trees. Others have been so trained at one time but have since been neglected, so that the orchard has the appearance of rows of trees with a thicket of shoots surrounding each tree. In time, of course, a greater part of the tree's production will occur on the bushy part of such trees. Yield per tree, however, tends to diminish with neglect.

As the trees usually are trained by pruning to have about five limbs, it was decided to use a fifth of a tree or bush as the unit on which nuts were counted. Samplers were instructed to divide sample trees by limbs into approximately five equal parts and to select one of those at random. Dividing the tree into five approximately equal parts is, of course, based upon sampler judgment. On the average a fifth of the bearing portion of all sample trees would thus be counted.

It was also decided to investigate an alternative to the expansion factor derived from this sampling rate. In some of the studies mentioned earlier, it has been discovered that the sum of the cross-sectional areas of the branches of a tree at any stage of subdivision is equal to the cross-sectional area of the trunk. The loss of limbs or branches, by accident or pruning, would decrease this relationship. If the relationship holds true for filbert trees the ratio of the cross-sectional area of the trunk of the tree to the cross-sectional area of the sample limb should provide a more accurate expansion factor. To get some data on this point the circumference of each sample limb was measured at about a hand's width above the crotch, and the circumference of the trunk at about the same distance below the crotch.

For a bush not trained into the shape of a tree, a fifth of the shoots were taken as the sampling unit and all shoots measured.

Nut Counts and Other Observations

Filbert nuts grow in clusters, usually of from 1 to 4 nuts each, but there may be as many as 16 or more in a single cluster. It is not practical to count individual nuts. A count was made of all clusters, and every 15th cluster, starting with a random number from 1 to 15, was picked from the tree. Counts of nuts per cluster were made in the orchard. These nuts were placed in a paper bag and taken to the office for observations on green and dry weight, and on defects such as blanks and worm damage, and other conditions of quality.

A subsample of 30 orchards in Yamhill, Washington, and Clackamas Counties was selected from the main sample for more intensive observations. One tree in each orchard was marked. The total set of clusters of nuts was counted and sample clusters on the entire tree were collected as in the case of the main sample. At 2-week intervals after the original count, additional visits were made to these sample trees to collect data on the numbers of clusters that dropped during the growing season. Sample clusters were also picked from surrounding trees to obtain data on the growth of nuts and changes in quality factors. At harvest time all nuts from the trees in the subsample were harvested, counted, weighed and subjected to crack tests.

Development of a Forecasting Procedure

A workable forecasting procedure involves a practical sampling scheme for selecting orchards, trees, and parts of trees for observation. The procedure also requires a knowledge of the relationship of nut counts, size, and quality early in the season to the yield at harvest time. The sample is designed to permit direct expansion of observations to the level of the universe, although the use of percent-change indications will undoubtedly prove to be more efficient. With such an estimating procedure it is still desirable to have a sample that permits direct expansion.

The relationship of early-season observations to final yields can not be ascertained accurately until more experience has been obtained. A yield forecast as of any specified date involves predicting (1) how many nuts on the trees at that time will develop to maturity, and (2) the size, weight, and quality of the ripe nuts when that stage is reached. Normal losses that may occur during harvesting must also be taken into account.

Any early-season forecast must start with a count of nuts present at the time of the forecast. Experience will show whether the percentage drop and the percentage reaching maturity tend to remain fairly constant from year to year or, if not, whether those percentages can be predicted from observable weather factors or other variables. Assuming that the number of nuts that will reach maturity can be predicted, it is also necessary to predict size and weight at maturity. A study of growth will be needed to devise procedures for predicting size and weight of nuts at maturity from observations on immature nuts. The ratio of growth increments from one year to another may be useful in modifying the eventual ratio formula to be used.

It is reasonable to expect that factors affecting growth can be identified and that predictions of mature size and weight can be made from early-season observations. Quality of the product at harvest probably is closely related to weather factors and to earlier worm or disease damage. Experience should shed light on these matters.

So far as harvesting losses associated with harvesting the mature crop are concerned, it is still necessary to learn whether such losses tend to be constant, percentagewise, or whether they depend upon the characteristics of the crop and other factors from year to year. But here, too, it seems reasonable to suppose that such losses will behave in a predictable fashion.