(iv) The establishment of regional fruit experiment stations in these tracts for studying the fruit growing problems and also for training personnel for horticultural extension work have been suggested.

REFERENCES:

1. CHEEMA, Dr. G. S. (1948). Fruit Policy in the Indian Union, Fruit Souvenir of the Provincial Fruit Show, Madras, 1948; Published by the Dep. of Aric., Madras, Pp. 3–4.

2. NAIK, Dr. K. C. (1948). Our Fruit Industry and Its Future, Fruit Souvenir of the Provincial Fruit Show, Madras, 1948; Published by the Dep. of Agric., Madras, 1948.

3. NARASINGA RAU, U. (1951). The Horticultural Approach in Maximising Food Production, Mad. Agri. Jour., Vol. XXXVIII, Feb. 1951, No. 2, Pp. 105–108.

A Review of the Methods of Crop Estimation and Forecast

By

K. A. KRISHNAN, B. A. (HONS.),
(Research Student, Paddy Section, Agricultural Research Institute, Coimbatore.)

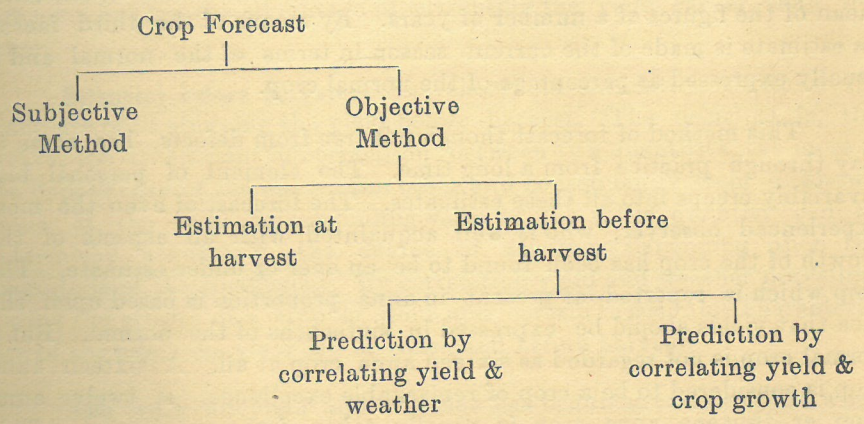
"It is of primary importance to an agricultural country like India, that it should possess accurate agricultural Statistics which would give at any time a reliable indication of the country's requirements of each agricultural commodity, its exportable surplus if any and its economic position as indicated by supply and demand." (11). A continuous supply of precise and accurate statistical information is a crying need of the modern industrial and economic activities.

Statistics of production engaged the attention of the Board of Agriculture in India, for the first time in the year 1919 when it dealt with the subject of forecast and estimation of crops. Forecasts and estimation of crops, commercial as well as agricultural are of considerable importance to the country. Information of the most probable production

of non-food crops much in advance of the actual harvest is of commercial importance since for trade and industry the availability of raw materials is the basis of all calculations of manufacturing processes. Again for ensuring self sufficiency in food and their equitable distribution reliable estimates of agricultural crops are of great value. For a country like India, where tax from lands is a principal source of revenue, correct estimate of the produce is much more essential for administrative purposes.

The forecasts of important crops are issued at suitable intervals in our country as well as in others, so that the markets of India and other countries may know what quantity each crop is likely to produce at different periods. "Such information when timely and accurate discourages wild speculation and reduces the risk of market panic" (11). The outturn of a crop in a particular year is estimated by each of the Provinces and States and the total gives the production for the whole Country.

Methods of forecasting: The main methods of forecasting can broadly be divided into two kinds, subjective and objective.



Subjective Method of forecast: The subjective method of forecast is based on the crop reporters' opinion of the prospects of growing crop after inspection. Usually they take into account their previous experience and the effect of previous weather conditions on them. This method has been prevalent in India as well as in other countries like England and America. In England, it is said (5) that during 1929 there were 300 crop reporters from whom the Government obtained the estimates of produce. Of the two essential factors to determine the produce viz. acreage and yield per acre, the crop reports of England had no difficulty in obtaining the precise figure of acreage since under the Agricultural Returns Act, information regarding this was made easily available to the crop reporters. In United States also such crop reporters

were employed. They gave the acreage figure as a percentage of the usual acreage and estimated the conditions of the crop in terms of the percentage normal. In India the forecast is based on the figures supplied by the village officials and is made on the basis of the following formula:—

Yield = Area × Standard or Normal outturn per acre × condition factor.

Of these three factors brought in for framing an estimate, the acreage figures in India are considered to be very accurate in most of the provinces, except in permanently settled areas, as the register maintained by every village contains the area brought under actual cultivation every year. For the second factor, the official definition of normal yields is the yield of "that crop which past experience has shown to be the most generally recurring crop in a series of years, the typical crop of the area, the crop which the cultivator has a right to expect and with which he should be content, while if he gets more he has reason to rejoice and if less he has reason to complain." The Manual of crop forecasts defines the normal yield as "the average yield on average soil in a year of average character". In statistical term it is the 'mode' and not the arithmetical mean of the figures of a number of years. By means of the third factor, an estimate is made of the current season in terms of the normal and is usually expressed as percentage of the normal crop.

This method of forecast though not free from defects, has come to stay through practice from a long time. The element of personal bias invariably creeps into all these estimates. The forecast of even the most experienced observer, who is well acquainted with all aspects of the growth of the crop has been found to be an over or under estimate. The crop which is reported at present in anna proportion is based upon the idea that yields should be expressed in sixteenths of the normal. But a normal crop is not regarded as sixteen anna crop at all. A sixteen anna crop is considered to be a crop of remarkable excellence. A twelve anna crop or thirteen anna crop is usually taken for normal crop. This conception of normal crop varies from province to province and for lack of uniformity in the adoption of this, forecast of the country as a whole cannot ensure sufficient accuracy. "Considered as a scale for measuring the condition of the crop, anna valuation suffers from the service limitation, that the officials concerned usually tend to give anna values which are within a fairly narrow range on either side of the normal figure and to avoid more extreme deviations. The result is that the yield is over estimated when the crop is poor and under estimated when the crop is really good." (7). Hence it has been suggested that these figures are to be worked out scientifically, taking into consideration all factors that influence the yield. A proper classification of soil together with a statistical study and analysis of the yield for a number of years may be

expected to lead to a more reliable figure. It is also important that these figures have to be checked and revised periodically.

Objective Method: Apart from the subjective method of forecast depending purely on personal inspection and experience only the objective method has been shown to be not only more accurate but in many cases available considerably earlier. This method is now receiving greater attention. It is based upon the fact that greater part of the variation of yield from year to year is due to variations in meteorological conditions. Certain measureable characteristics are also studied to predict the yield. But these characteristics of the plant or crop are allied to many factors like cultural practice employed, manurial treatment involved, soil fertility and above all the growth habits of the crop. As a consequence this method demands a preliminary programme of research extending over several years. The Crop Weather Scheme on wheat of the Ministry of Agriculture in England is an example of the scientific attempt towards predicting the yield from the standing crop.

This method divides itself into two parts according as estimates are required before harvest or at harvest. The former presents more difficulty but has the advantage of predicting the yield earlier than the other.

Estimates before harvest: The theory of correlation is extensively made use of in studying the yield before harvest. The principle is, the greater the co-efficient of correlation between two quantities, the more is the dependence of the one on the other and consequently from a known value of the one, corresponding value of the other quantity can be determined accurately, the degree of accuracy depending upon the magnitude of the co-efficient. By correlating yield and weather prevailing during the growth of a crop or yield and certain measurable characteristics of the plant the yield can be estimated before harvest.

The work on yield and weather has begun as early as 1874 when Rawson examined the relation between sugar crop and rainfall in the island of Barbados. The relation between winter rainfall and wheat yield was studied by Gilbert in 1880. At the beginning of the twentieth century Hooker applied for the first time statistical methods for such studies. In 1918 Prof. Fisher did the pioneer work in the same line. During 1917 Moore in America studied cotton yield in relation to weather and " this was the first scientific criticism of official methods of forecasting crops. (2) Work on the same subject has been done to a great extent by Smith 1927, Kincer in 1915 and Maltice in 1928. In all their study, the knowledge of Agricultural Meteorology found ready application.

In India interesting work has been done by Mr. Jacob correlating rainfall and yield and established the prediction formula based upon the

data for thirty years. The Royal Commission on Agriculture has remarked "Very little attempt has been made to correlate the two sets of data, the two valuable studies published so far by Mr. Jacob, I. C. S. (Retd.) represent so far as we are aware the only instances of this kind". In 1929 Unaker studied the relation between weather and crops with special reference to Punjab wheat.

The prediction of yield is established in the form of regress in equations, after analysing statistically, meteorological figures and yield for a number of previous years. Thus the prediction equation for the paddy yield has been worked out (1) to be

$$x_0 = 3{\cdot}179x_1 + {\cdot}033x_2 - 1{\cdot}459x_3 - 73{\cdot}25$$

where x_0 stands for yield, x_1 for area, x_2 for rainfall, and x_3 for temperature. In the same way the yield of cotton (11) is given by

$$x_0 = 524{\cdot}77 + 0{\cdot}129x_1 - 4{\cdot}32x_3 - 0{\cdot}013x_4$$

where x_0 represents the yield, x_1 September rainfall x_3 November temperature, and x_4 harvest rainfall.

Again correlating yield and measurements of the growing crop, Cochran has established (3) the production formula for wheat. He has expressed yield in terms of the shoot height, plant and ear numbers. This is a more promising result since the changes in soil fertility, amount of manuring and cultivation may all reflect themselves in the condition of a crop at a given stage.

Estimation of yield at harvest—crop cutting experiments: When the crop is ready for harvest the produce can be estimated by harvesting a sample of the harvesting crop and weighing the produce. The earliest experiments based on this principle were carried out by Mr. Hubback in India between years 1923 and 1925. These methods were subsequently applied by Deshmukh in Central Provinces.

As early as 1919 the Board of Agriculture while considering the possibility of improving crop forecasts, recommended that crop cutting experiments should continue to be the basis on which the normal or standard yield should be worked out. The subject was considered again in 1924 and the need for increasing the number of experiments and the adoption of the random selection was stressed. Random sampling is a procedure based on laws of chance, of selecting a part of the material to represent the whole. The method is entirely objective and rules out the possibility that the the outcome of the draw in the sample will be influenced by the experimenter. The great advantage of random selection has been illustrated by Dr. Yates in his paper on "Some examples of biassed sampling". To determine whether the sampling is adequate or not, an estimate of the sampling error is necessary which can be worked

out only for random samples. For example, if the estimate is to be correct within one error or r% and the co-efficient of variation of the estimate is v the number of experiments (n) to be conducted is given by

$$\frac{v}{\sqrt{n}} = r \text{ or } n = \frac{v^2}{r^2}$$

which shows the number of experiments is directly proportional to the sampling error. Prof. Mahalanobis has devised a sampling technique to find the area under jute in Bengal and Dr. Panse has adopted a similar method in estimating the yield of cotton in Akola district. Sufficient number of experiments, homogeneous zones and strictly random selection are the essential features of a crop-cutting experiment soundly devised. Such experiments lead to an unbiassed estimate of the normal yield which in turn results in reliable estimates of the total produce.

"Post-mortem examinations": In order to find how far the figures given by the forecast reflected the actual produce of a crop, it is of great importance and necessity that intensive efforts should be made to examine the crop actually harvested. The figures thus obtained, placed in comparison with the forecast figures afford a measure of precision of the forecast. In order to trace the sources of error and improve the subsequent forecasts, the Indian Central Cotton Committee has been subjecting the official forecasts of cotton to a 'post mortem examination' and the discrepencies noticed are brought to the attention of forecasting authorities for remedial measures. For crops such as cotton and jute an independent estimate is possible since detailed statistics can be obtained from traders, mill owners etc. who handle the crop in bulk. Similarly for plantation crops like coffee and rubber, statistics of production can be ascertained as these materials pass thro' manufacturing processess at definite places. But in the cases of commodities produced primarily for consumption there is a difficulty in arriving at independent estimate. However since the inception of the National Sample Survey by the Government of India this has become possible, for from the consumption figures which they gather on random sampling basis, the output of food grains can be deduced. This affords an excellent facility for the comparison of figures obtained by entirely differant approaches. The official forecast of foodgrains for the year 1949—'50 was 45 million tons. But the report of the National Sample Survey recently published shows that, as a result of its study of consumption on stratified random sampling basis, the figure of output as 60 million tons. This again is a challenge to the official forecast. However as Prof. Mahalanobis has stated too much faith on the first round of survey alone should not be placed, and as such, the results of the other three rounds of its survey are eagerly awaited. A scientific comparison of the two sets of data and evaluation of results will go a long way for assessing the production estimate with reasonable degree of accuracy.

Acknowledgement: The paper is prepared during the period of the author's training in Agricultural Statistics, in the Paddy section of the Agricultural College and Research Institute, Coimbatore, as kindly permitted by the Government of Madras. The author gratefully acknowledges the help received from Sri M. B. V. Narasinga Rao, B. A., B. Sc. (Ag.), Paddy Specialist, in the course of the preparation of this paper. His thanks are also due to Sri C. Balasubramniam, B. A., B. Sc. (Ag.), Agricultural Meteorologist, for valuable guidance.

REFERENCES.

1. Adyantaya, N. K. (1931) : The Madras Agricultural Journal Vol. XIX.
2. Anantapadmanabha (Rao 1938) : Tournal of the Mysore Agricultural and Experimental Union. Vol. XVII.
3. Cochran (1938) : Suppl. Journ. Roy. Stat. Society Vol. 7.
4. Hubback (1927) : Indian Journal of Statistics Vol. 7.
5. Irwin (1938) : Suppl. Jour. Roy. Stat. Society Vol. 7.
6. Panse and Kalamkar (1944) : Current Science, Vol. XIII.
7. Panse, V. G. (1951) : Indian Cotton Growing Review, Vol. 5.
8. Ramakrishnan, S. (1934) : Indian Journal of Statistics Vol. 2.
9. Subramania Iyer (1942) : Indian Farming, 1942.
10. Thomas and Sastry (1939) : Indian Agricultural Statistics
11. Vaidyanathan, M. (1232) : Agriculture and Livestock in India Vol. II.

Methods to be Adopted to Maximise Production and Development of Improved Strains and Plant Materials*

Cardamoms

By

V. GOMATHINAYAGAM PILLAI,
(Cardamom Specialist)

Cardamom is an indigenous spice of South India. It is cultivated in about 1,08,000 acres on the hills as a plantation crop. It is a perennial, yielding about 33–35 pounds of dry capsules per acre per annum. About 80% of the total production is exported mostly to the hard currency area. Though this crop does not contribute directly to the food wealth of South India, it is definitely a good dollar earning crop. The price of cardamom has risen up high recently to about Rs. 10/- per pound. Hence, there is now an urge on the part of the planters for manuring their cardamom crop to maximise production. Usually the cardamom crop is not manured.

* Paper contributed for College Day & Conference 1952.