

- Analytical studies of data should be encouraged. The Society may contribute significantly in this respect through taking up need based analytical studies in the form of research projects.
- Multidisciplinary studies utilising data from various sources should be taken up. For this purpose linkages of research workers in statistics in various Institutes should be further strengthened.

The extended summaries of the papers are as follows :

I. Trend Analysis in Plantation Crops

M.V. George

Central Plantation Crops Research Institute, Kasaragod

India is the largest producer of arecanut, cashewnut, tea, ginger and turmeric and second largest producer of coconut, cardamom and pepper in the world. Since independence an increase in trend in the area and production of these crops were seen. However the trend in area or production are neither uniform among the crops nor over the periods, as the same were very much influenced by the climatic and seasonal changes, market prices, occurrence of drought and cyclones, out break of disease and pest incidence. This paper dwells at length the trend in area, production and productivity of all these crops for the past four decades, utilising the available data.

Coconut

There was an overall increase of 160 percent in area and 218 percent in production during 1992-93 compared to 1950-51 figures. The growth rates in area slid down to nearly zero during the seventies and further improved during eighties and in particular from 1986 onwards. The increase in production for the last ten years alone was about 96%. The compound growth rate for 1984-90 and 1990-93 were 9.85 and 8.29 respectively. The average productivity of 5759 nuts per ha during 1950-51 rose to 7032 during 1992-93. The compound growth rate which was negative during sixties and seventies became positive during late eighties and nineties.

Arecanut

Area and production trend of arecanut in India increased during the past 38 years. The area increased by 110% and production by 205%. The compound growth rate for area as well as production were generally positive and significant. The productivity of arecanut remained almost steady from 1957 to

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1974 with small fluctuations, then increased steadily to above 1000 kg/ha level and then reached the peak level of 1250 kg/ha during the year 1989-90.

Cashew

The area under cashew showed an increasing trend. There was an overall increase of 414 percent in area and 341 percent in production during 1993-94 when compared to 1955-56. The compound growth rates were all positive, high and significant. The productivity was showing a declining trend till the end of seventies. The highest productivity 768.2 kg/ha observed during 1957-58 had declined to 465 kg during 1975-76 and further to the lowest level of 314.27 kg/ha during 1979-80, about 60% reduction as compared to the level of productivity during 1957-58. The productivity increased from 452.35 kg/ha during 1985-86 and to 615.98 kg/ha during 1993-94.

Cocoa

The area under cocoa was showing a negative trend from the year 1983-84. The area under cocoa during the year 1983-84 was 22230 ha which came down to 13960 ha during 1991-92 whereas the production was fluctuating between 56100 and 77100 kg. However the productivity was almost increasing every year. The compound growth rate for area was negative and significant, but that of production was not significant. However, CGR of productivity was positive and significant.

Pepper

The area under pepper in India which was only 79000 ha during 1949-50 increased to 177360 ha during 1992-93. The compound growth rate of area was positive, high and significant. The production of pepper in India increased from 21000 tonnes during 1949-50 to 55190 tonnes during 1989-90. During the past 10 years i.e. from 1983-84 to 1992-93 the increase in production was around 138 percent and the compound growth rate was highest during the five year period 1984-89. As regards the productivity, it was stagnant within the range of 250-300 kg/ha with marginal fluctuations during the past 44 years. The lowest productivity was observed during the year 1984-85 mainly due to spread of quick wilt and loss of pepper vines in extensive areas consequent to the heavy and continuous rains in Kerala. However the productivity picked up from 1987 onwards.

Cardamom

The area under cardamom was showing an upward trend from 1955-56 to 1993-94 with occasional ups and downs. However the expansion of area was only 66 percent over the 38 years. The production was characterised by an overall increasing trend between 1955-56 and 1993-94, although the production was stagnant for few years. The trend in productivity was found highly fluctuating, ranging from 24 kg to 84 kg/ha without showing any regular trend.

Coffee

The area under coffee during 1950-51 was only 0.091 million ha and increased to 0.279 million ha during 1991-92. The production of 0.034 million tonnes during 1955-56 increased to 0.18 million tonnes during the year 1991-92. The compound growth rates for area as well as for production were all positive and significant. The productivity was highly fluctuating.

Tea

The area under and production of tea in India was showing an increasing trend. The area during 1956 was only 0.316 million ha which increased to 0.412 million ha during 1986 and then remained stationary for the last few years. The production of 0.285 million tonnes during the year 1956 increased to 0.715 million tonnes during 1990. The productivity was also showing an upward trend with ups and downs. The productivity of tea during the year 1956 was 902 kg/ha and increased to 1787 during 1990. The compound growth rate of area worked out for the five years period was positive and significant upto the period 1980-85 and there after it was negative. But the CGR of production was positive throughout and mostly significant. The CGR for productivity was also positive.

Rubber

The area under and production of rubber was in the increasing trend. The area under rubber during the year 1950-51 was only 0.059 million ha and rose to 0.5084 million ha during 1993-94. The production of rubber which was only 0.014 million tonnes during 1950-51 rose to 0.435 million tonnes during 1993-94, i.e. about 31 times increase over a period of 44 years. The compound growth rate of area and production for the five years period were all positive, high and significant. The productivity of rubber during 1950-51 which was 237 kg/ha increased to 856 kg/ha during 1993-94.

Ginger

The area under ginger was found to be fluctuating around 20,000 ha between 1949-50 to 1973-74. However, since 1974 an increasing trend was found. The area under ginger during 1972-73 was only 22870 ha, had increased to 58080 ha during the year 1992-93, about 154% increase over a period of 20 years. The production was about 24000 tonnes during 1949-50 and rose to the peak level of 189440 tonnes during 1992-93. The increase in production from 1983-84 to 1992-93 was of the order 84 percent. The productivity of ginger was found to be highly fluctuating around 1000 kg/ha or below from the year 1950-51 to 1969-70 thereafter it was showing an upward trend. The productivity which was 952 kg/ha during 1967-68 rose to 3262 kg/ha during 1992-93. As compared to fifties and sixties the productivity of ginger trebled during the nineties.

Turmeric

The area under turmeric remained around 50000 ha with little ups and downs from 1949-50 to 1961-62 and thereafter it was found increasing. The area rose from 68400 ha during 1972-73 to 128600 during the year 1992-93. The production of turmeric was mostly in the range of 130 to 150000 tonnes without much improvement from 1949-50 to 1978-79 and thereafter it had recorded substantial increase. It attained the peak level of 397400 tonnes during the year 1992-93, registering an increase of about 105 percent during the last 10 years. The productivity of turmeric did not improve much when compared to 1949-50.

Future Prospects

The overall trend in area and production of all these crops are positive and significant. From the trend analysis, it is estimated that the production of coconut by 2000 AD may reach 20000 million nuts from an estimated area of 2.1 million ha. The production of arecanut is estimated to exceed 3 lakh tonnes from an estimated area of 2.5 lakh ha. The cashew production is expected to reach 7 lakh tonnes by 2000 AD from an estimated area of 7 lakh ha. As per the trend the area under cocoa is not likely to increase. For pepper and cardamom the positive trend in area as well as production is likely to continue. By 2000 AD the pepper production is expected to reach one lakh tonnes from an estimated area of about 3 lakh ha. For cardamom though there is not much scope for area expansion there is scope for increasing the productivity of 81 kg/ha to 90 kg/ha and the estimated production of cardamom will be around 7000 tonnes. For coffee the production is likely to exceed 2.25 lakh tonnes from an estimated area of 3.18 lakh ha. For tea the scope for the expansion

of area is very limited. The production may reach 7.5 lakh tonnes by increasing the productivity. The positive and significant rate of increase in area, production and productivity of rubber is likely to continue. The estimated production of rubber will be around 6 lakh tonnes from an area of 6 lakh ha. For ginger and turmeric also considerable expansion in area and increase in production is expected.

2. Utilization of Available Data in Experiments with Plantation Crops

Jacob Mathew

Central Plantation Crops Research Institute, Kayangulam - 690 533

Special features of perennial plantation crops make experimentation difficult in such crops. Also because of the limitations of time, land etc. there are restrictions on starting new experiments, as and when required. Therefore, researchers are forced to critically look into old experimental data, to draw information regarding points, not originally envisaged, while starting the experiment. Some such instances, where old experimental data have been made use of to obtain information about optimum plot size, competition and border effect, method of compilation of annual yield, crop losses etc. are discussed below.

Uniformity trial data and optimum plot size.

Uniformity trials are intended to get an idea about the nature and extent of fertility variation in land. From the data collected from such trials, fertility contour maps showing lines passing through areas of equal fertility are generally prepared. In most cases, this variation in fertility, optimum size and shape of plots and blocks are determined. In plantation crops like coconut and oil palm, where the palm to palm distance is 7 to 9 m., in order to have a uniformity trial, at least 2 ha of land will be required. Usually it will be difficult to get this much of area under uniform management, and with individual tree yield records. Koch and Rogney (1951) and Ray et al. (1973) have suggested techniques to obtain uniformity trial data from experimental data, by eliminating the treatment effects, from the yield of individual palms. The resultant data are considered as uniformity trial data, and is used to estimate optimum size and shape of plots. Nambiar (1986, 1989) has used fertilizer trial data to estimate the optimum size of plots in the case of DXT and W.C. Tall palms, This technique will hold good only when the number of palms per plot is constant, and the yield figures are available for individual palms.

Border/competition effect

Owing to the border effect, the yield or other characters of the plants near the borders differ from those at the centre of the plot. To overcome these problems, non-experimental guard rows are usually suggested. It can be easily seen that when gross plot is smaller in size, a great proportion of the experimental area would be discarded as non-experimental margins. Gomez and Gomez (1984) have mentioned that competition effect can arise due to non-planted borders, varietal competition, fertilizer competition and missing plots, and have suggested experiments to measure competition effects. They have also suggested techniques to estimate this competition effects from the data available from other experiments. Data from an irrigation-cum-fertilizer-cum-variety experiment was made use of to study the necessity or otherwise of external guard rows and guard rows between unirrigated and irrigated plots in coconut field experiments (Jacob Mathew et al. unpublished). Similarly, data from a cocoa+areca mixed cropping experiment was used by Jose et al. (1993) to study intra and inter component competition.

Crop loss assessment

Crop loss assessment requires the collection of large amount of data in order to understand the interaction of factors that may be affecting the yield. These data need to be collected through surveys and field experiments. Field experiments tend to be more limited in scope, providing data on few specific factors affecting particular crop, and their relationship to that crop yield. Recently data collected from a fertilizer experiment was made use of to study the impact of root (wilt) disease on the yield of young coconut palms (Jacob Mathew et al. 1993). Data from some of the field experiments in the disciplines of crop improvement and crop production have also been made use to study the extent of bienniality in different varieties of coconut (Jacob Mathew & Jose 1990) method of compilation of annual yield (Jacob Mathew et al. 1990) etc. Thus it is clear that in the case of plantation crops, the necessity is more and the possibilities are also plenty for the use of data available from different experiments, for purposes other than what was originally envisaged for, while starting the experiment.

3. Data Analysis in Forestry Sector

K. Jayaraman

Kerala Forest Research Institute, Peechi, Trichur

Certain instances in forestry where conventional sampling, design and analytical techniques are not sufficient, are briefly referred to with indication

on possible solutions that have been offered. The problems covered pertain to the estimation of animal abundance in forests through line transect sampling, projection of stand structural changes in forests through simulation, analysis of repeated measurements through univariate mixed model/multivariate analysis and also the construction of a multivariate selection index using regression with indicator response variable.

Estimation of animal abundance in forests

Most of the conventional sampling schemes deal with populations of stationary objects for which a sampling frame can be prepared. In the case of wildlife, the sampling units are not stationary and the very objective in most cases will be to estimate the total number of units in the population. The procedures get even more difficult with individuals which occur in low density, which are often difficult to see (nocturnal, shy or flee or hide), which can fluctuate widely in numbers and distribution from season to season and year to year, and can sometimes fight back. Certain specialized methods have been evolved to deal with the situation like capture-recapture technique, line transect sampling, bounded count method and methods based on indirect evidences like hoof marks, pugmarks, pellet or dung counts. Of the several methods, line transect sampling has been found to have several advantages by way of ease of execution in the field and by being a direct sighting method. Of late, the theoretical basis of this method has been thoroughly investigated and several advancements have been made in the estimation procedures.

Projection of structural changes in forests

Forests are complex dynamic entities undergoing continuous structural modifications by way of natural regeneration, survivor growth and mortality. In managed forests, there is the additional human intervention in the form of periodical harvests. Natural forests consist of trees of several species of different age/size classes competing with each other for their survival. Forests, natural or man-made have long gestation period and studies on the effect of alternative management strategies on such systems are not amenable to conventional experimentation based on field observations over long periods. Instead, modelling and simulation techniques are resorted to, for answering questions related to the optimum management schedules. A typical mode based on transition matrices is given by Buongiorno and Michie (1980).

Analysis of repeated measures

The case of repeated measurements is a very common situation in forestry. The term 'repeated' is used to mean measurements which are made of the same

characteristic on the observational unit but on more than one occasion. Typical examples are periodical measurements on diameter, height and crown size of trees in a silvicultural trial. Repeated measurements may be spatial rather than temporal. For instance, consider measurements on wood characteristics of several stems at bottom, middle and top portion of each stem, each set of stems coming from a different species. Another example is concerned with soil properties observed from multiple core samples at 0-20 cm, 20-40 cm, 40-60 cm depth from different types of vegetation. Different ways of analysing repeated measures have been proposed in the past (Crowder and Hand, 1990). These methods vary in their efficiency and appropriateness depending upon the nature of data. In routine analysis, repeated measurements over time or space within an individual are simply taken as levels of a factor and analysis is done ignoring the possible within subject correlations. This is not a satisfactory procedure. Certain more refined procedures are available.

Univariate mixed model analysis of variance

[See Rouanet & Lepine (1990); Mauchly (1940); Box(1949)]

Multivariate analysis of variance

[See Crowden & Hand (1990); Morrison (1970)]

A multivariate selection index for vegetative propagation

Multivariate selection and ranking procedures are usually based on Mahalanobis Distance function or linear combination of the elements of mean vector (Krishnaiah, 1966). But there could be instances where functions other than the above are to be used in selection procedures. These are discussed in the paper.

4. Utilisation of Survey Data in Fisheries Technology

H. Krishna Iyer

Central Institute of Fisheries Technology Cochin - 682029

Data are essential for planning, management and development in all fields, especially in Fisheries. The Central Institute of Fisheries Technology has made many studies involving survey and collection of data in connection with fishing and fish processing industry. Some of the surveys undertaken in the past are indicated. The analysis of data were carried out keeping in view the objectives. However, these data can be examined again to have some deeper analysis or to extract additional information.