PROCEEDINGS OF THE SYMPOSIUM ON "STATISTICAL ASPECTS OF DIFFERENT CROPPING SYSTEMS"

Chairman : Shri J.S. Sarma*

Convenor : Dr. P.R. Sreenath¤

At the outset, Prof. Prem Narain, Secretary, Indian Society of Agricultural Statistics welcomed the participants and the speakers. He requested Shri. J.S. Sarma, former Economic and Statistical Advisor, Ministry of Agriculture, Government of India to chair the session. Having introduced the Chairman and the Convenor to the participants Prof. Prem Narain highlighted the imprtance of the topic for the symposium for meeting the requirements of the recent priorities in the Agricultural Research.

The Chairman, in his opening remarks, dwelt on the complexities of the cropping systems research including the collection of data and its statistical analysis for arriving at sound results taking into account the sustainability of the system, its effect on the environment and several other related issues. The invited speakers were then requested to present their papers.

In all, seven speakers i.e, Dr. G. Nageswara Rao, Dr. P.R. Sreenath, Dr. D.M. Hegde, Dr. N. M. Patel, Dr. P.B. Parthasarathy, Shri. C.K. Ramanatha Chetty and Shri. U.M. Bhaskara Rao presented their papers in this sequence. Abstract of the paper received from Shri. P.N. Soni was circulated. While the first two presentations related to intercropping system, the next three dealt with problems relating to multiple cropping and rotation experiments. The last two presentations were on Agroforestry system. Presentations of each group of papers was followed by brief discussions with the participants taking keen interest.

The following recommendations emanated from the presentations, discussions and the Chairman's observations.

> There is no single standard method available for the analysis of data from cropping systems and hence such data need to be subjected to several analyses.

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Table 5. World Population and Energy, 1850–1990.

Year	World population (billions)	Energy use per person (KW)		World energy use (TW)		Total	Commu-lative use of industrial energy forms since 1850 (TWy)
		Industrial forms	Traditional forms	Industrial forms	Traditional forms		
1850	1.13	0.10	0.50	0.11	0.57	0.68	0.0
1870	1.30	0.16	0.45	0.21	0.59	0.79	3.2
1890	1.49	0.32	0.35	0.48	0.52	1.00	10.1
1910	1.70	0.64	0.30	1.09	0.51	1.60	25.7
1930	2.02	0.85	0.28	1.71	0.56	2.28	53.7
1950	2.51	1.03	0.27	2.58	0.68	3.26	96.6
1970	3.62	2.04	0.27	7.38	0.68	8.36	196.3
1990	5.32	2.19	0.29	11.66	1.54	13.20	386.7

- Studies are required to provide the experimenter with an answer to when/where/how the suggested methods of analysis are to be applied. Such answers need to be given in terms of the experimental conditions and requirements as also the nature of the data to be analysed.
- Efforts are needed for analysis of data from cropping systems for stability and sustainability of the systems.
- The use of multi-objective analysis technique and suitable non-parametric techniques need to be explored.
- In-depth studies are needed for developing statistical proceedures, including design and analysis of experiments, for Agro-forestry Research. A collaborative research effort between CRIDA and IASRI on the one hand and ICRAF on the other is required.

The summaries of the papers presented and discussed are as follows:

1. Statistical Aspects of Intercropping Systems.

G. Nageswara Rao*

The methods of analysis for intercropping experiments such as Bivariate analysis, Land Equivalent Ratio (LER) with four standardisation methods, Effective Land Equivalent Ratio (ELER), Stable Land Equivalent Ratio (SLER), Monetary Advantage (MA) and Relative Net Return Index (RNR) were briefly discussed. The four standardisation methods used for LER were (i) replication yield of the corresponding sole crop treatment, (ii) the average yield of each sole crop treatment from all replications, (iii) replicationwise yield of the best (sole crop) genotype and (iv) the average yield of the best (sole crop) genotype from all replications. These methods were compared with the help of experimental data of nine intercropping experiments conducted at different locations. Of these nine experiments three were on genotypes only, four were on row arrangements and the remaining two were involving both the genotypes and row arrangements. The results of this study are as follows.

In two of the experiments with genotypes only, Bivariate, LER and MA methods gave similar conclusions based on F-test. For the third genotype experiment, LER method gave different conclusions as those from the Bivariate and MA methods. In the case of four experiments with row arrangments, the conclusions from F-test for different methods were the same in only one

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experiment and differed for the other three experiments. In these three experiments while the LER and MA methods identified the same supperior treatments the Bivariate method identified them differently. The Bivariate, LER, MA and RNR methods were almost giving the same conclusions for the experiments involving both the genotypes and row arrangements. In general it was observed that Bivariate, LER and MA methods gave similar conclusions for four out the nine experiments based on the F-statistic. Bivariate method appeared to be a sound one statistically and RNR index method could be preferred from farmers point of view.

2. On Statistical Analysis of Data From Intercropping Experiments

P.R. Sreenath*

Many of the indices used for the univariate method of analysis of data from intercropping experiments turn out to be only linear combinations of the component crop yields, the coefficients used for combining these yields being different for different indices, situations, occasions etc. A single method of analysis of such combined yields with a view to obtaining the limits of the relative coefficient used, for significance or otherwise of the contrasts of interest and drawing conclusions over the range of values or different values for different cases as applicable depending upon the requirements of the different indices/situations/occasions was proposed and briefly outlined.

It was noted that the Bivariate method of analysis of data could give significant results more often than warranted when the component crpops or threatments exhibit compensatory effects.Involvement of certain treatments such as crop geometry could also lead to the problem of unequal variances.

Data from eleven experiments on intercropping of Wheat and Gram conducted in the past under All India Co-ordinated Agronomic Research Project were analysed for the study. The experiments were in Randomised Complete Block Design with 10 treatments viz., Pure stands of Wheat and Gram crops along with the combinations of 4 mixture ratios (1: 1, 2:1, 3:1 and 5:1) of Wheat and Gram and 2 methods of sowing (intercropping and mixed cropping). For examining for inequalities, if any, of the variances associated with the tratments or factors, the Error s.s. was split into different components and the appropriate mean sums of squares due to these error components were tested for equality using approximate chi-square test. This examination showed that there was little reason to believe that the variances for the Wheat yields were unequal except

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in one set or experiment, where the variance for the pure crop was significantly higher (28 times). However, such analysis of Gram yields showed that (i) in only four sets the equality of variances could be assumed, (ii) in two of the sets the variance associated with pure crop plots was higher (7 and 19 times), (iii) in three sets the variances associated with different treatments differed significantly from one another, (iv) in one set they differed as per the ratios, and (v) in one set they differed as per the method of sowing. The tests of significance for various treatment component contrasts in case of unequal variances were carried out alternatively (i) making use of appropriate component error m.s. and (ii) using approximate F-Statistic based on the estimated relative values of the unequal variances. The conclusions drawn under the above alternatives and under the homoscadastic model differed from one another in few of the cases.

The comparison of the bivariate method of analysis with the univariate method was undertaken. The weight for Wheat yields was taken to be unity. The relative weight for Gram yield (W) for analysis on the basis of protein yield, energy yield, LER, Gross returns etc., were worked out on the basis of available information to be 1.44, 1.04, ranging between 2 and 6, and ranging between 2 and 10 respectively. (The need for the ranges was due to the fact that the experiments were conducted at different places and times.) The data for the pure crop treatments was to be obviously, excluded from this analysis.

The bivariate analysis showed that the ratios were significantly different (1% level) in all the trials except that at Parbhani 78-79. The univariate analysis showed that (i) at Jabalpur 78-79 the ratios differed significantly only in terms of energy production, (ii) at Jabalpur 80-81 they are significantly different in terms of LER and gross returns for $W > 2.84$, (iii) at Ranchi 87-88 they are significantly different always, (iv) at Bhagalpur 85-86 they differed significantly in terms of protein content for $W < 1.38$ and in terms of LER and gross returns for $W > 3.08$ and (v) at Varanasi 85-86 they differed in terms of gross returns and LER for $W < 3.36$. The bivariate analysis showed that the Methods were significant in 9 of the trials where as the univariate method showed such significance in only 6 of these trials that too for certain ranges of the W. The bivariate method showed the Ratio x method interaction to be significant in 6 of the trials where as the univariate method showed this interaction to be not significant in all the trials whatever the value of W be. For pairwise comparison of the levels of different factors, in case of real significance under the bivariate method, drawing of contours would be necessary. The univariate method provides such comparisons on similar lines as in the analysis of variance discussed above.

3. Some Reflections on Statistics of Multiple and Rotational Cropping

D.M.Hegde*

This paper gives an Agronomist's view of the statistical aspects of multiple and rotational cropping. Rotation experiments, in both field and resource management, are complex, since the rotations exist for many years and research personnel change. Multiple cropping experiments are rather simple in design but esxpensive in resource use. Design flaws in a rotation experiment can have serious consequences, relative to flaws in an annual experiment. It is, thus, imperative that broad objectives be moulded and tooled into specific practical objectives so that statistical analyses also outlined at the design stage will yield clear interpretations.

A first step in statistical analysis of rotation experiment is the straightforward analysis of variance for each year. A combined analysis of variance is carried out thereafter. Invariably the rotations x years interaction will be important and the analyses can be expanded to incorporate the concepts of cycles and series into the analysis. But first, the assumption of independent errors ofthe residual term needs to be examined. The evaluation of the correlation between residuals (error) from year to year, called the serial plot correlation, should be part of a rotation experimental analysis. Several potential approaches to the repeated measurements made on the same experimental units are available. The usual analysis of variance technique does not answer directly questions posed by users of rotation experimental results.

A rotation system affects the soil fertility and the direct, residual and cumulative or rotational effects are defined in terms of cycles. As the objective of a rotation system is to increase or maximise long-term farming benefit (profit), the rotation effects have an upward trened and will stabilize in the long run. There are rotation systems, however, that have negative direct and residual effects. These systems cause deterioration of soil fertility over the cycles and, therefore, the rotation effects have a declining trend. Whether rotation effects increase or decrease as the cycles advance, the trend can be, and has long been, measured in terms of the change in crop yield. The use of linear and quadratic terms to represent the trend of yield changes have been amply demonstrated, in the literature.

As rotation effects stabilize, the yield of the rotation approaches a constant, called the limiting or asymptotic yield. Associated with an rotation and management combination is a limiting yield which, if known will indicate its long-term or stabilized yield. This is a valuable information for research workers

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wishing to compare the relative merits of various rotation systems or deciding when to close out a rotation experiment.

One of the objectives in rotation experiments is comparison between rotations. One form that this comparison takes is the comparison of yields of the same crop belonging to different rotations. These comparisons are simple when the rotations are of same length. This simplicity disappears when rotations are of different lengths. A further difficulty arises in making a comparison between two rotations over shorter period when crop cycles are not complete in one or other rotation. The only method of analysis available in this situation is by fitting constants for plots as well as years, making the analysis complicated.

One of the major objectives for comparing different multiple cropping systems is to compare their productivity in terms of economic returns. This is also an important short-terms objective in many rotation experiments. Economic viability of a cropping system can be determined by a budget analysis.

Most of the agronomists are now recognising the importance of yield stability in cropping systems. Issues concerning sustainability of different cropping systems are also getting increasing focus in recent years. The difficulty involved in carrying out meaningful studies to determine the actual degree of stability for any given situation is the basic problem. Further difficulty has been the general lack of methods of quantifying stability and sustainability. Efforts have been hampered by lack of standard system of expressing the magnitude or degree of stability.

4. Some Statistical Aspects of Multiple Cropping and Rotataional Experiments

N.M. Patel*

The field experimentation on crop rotation are categorized in three groups viz., (i) short term rotation experiments with few cycles with or without agronomic treatments, (ii) long term fixed rotation experiments with superimposed agronomic treatments on one crop sequence with many cycles, and (iii) multi-rotation experiments with or without agronomic treatments. The literature indicates that in India majority of the rotation experiments (80%) were conducted for 2 or 3 years (seasons) period. Such experiments having short duration are defined by agronomists as multiple cropping experiments or crop sequences experiments and can be analysed following available methods. The rotation experiments of categories (ii) and (iii) need maximum care in planning and management. In planning rotation experiment, treatment design

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and experimental design are important considerations in data analysis. The other basic need specific to rotation experiments is that each phase of a rotation must appear each year.

One is interested in the rotation experiments to study the variation in the yield data generated over years. This variation could be due to seasonal or climatic variation, deterioration or improvement of soil conditions, and cumulative effect of rotations and/or treatments. Besides the yield data, experimenter should keep close watch in each plot and record pests and diseases, soil data - nutritional status, pH values etc. and weather data. Such observations will help in explaining unusual deviations in data and also in modelling. If a variate is obtained by sampling from the plots, the sample size and sampling proceedure shoud be specified and recorded. The major consideration in analysis of data is the estimation, testing and adjustment for serial correlation entering into the data due to repeated measurements made on the same plot. Statistical methods for analysis of repeated measurements made on the same experimental units are available. Three options are described, in the literature, in terms of assumptions needed and power to detect significance of differences. The usual split-plot analysis taking time (years) as sub-plot treatments, is not efficient when correlation is significant. The use of multivariate analysis using yearly data as the multiple response is also possible but interpretations are not straight forward. The third approach suggested is that of fitting of orthogonal polynomials to the repeated measurements for each plot. These polynomials are treated as data and are analysed. Experimental error is also partitioned to give seperate errors for analysis of each orthogonal polynomial coefficient.

In statistical analysis of rotation experimetns (long term) the main interest is to study long term effects. This could be done through regression analysis or modelling and is possible only if the experiments are conducted for longer duration (more than 10 years). Information on multi-rotation experiments run for more than ten effective years is lacking. The experiments involving monocropping system with agronomic treatments are, however, in progress at various locations. They are at best longterm agronomic experiments and can be analysed using regression analysis (modelling) for interpreting long term effects.

It is not proper to run long term experimetn with a single variety. Adoption of new varieties, generally high yielding, can affect results as seen in trials involving Bidi Tobacco. Similarly incorporation of other inputs can also alter the results. Attempts are required for accounting for such changes/shifts in statistical analysis. Perhaps time series analysis may help in such data analysis.

Comparison of agronomic treatments appears to be easier as compared to rotations (multi-rotation). The crop sequences are not similar in nature with each rotation, whereas one has to study the relative performance of rotations over years. At present, analysis is done by converting produce into monetary value (realisation). Since price of farm produce varies seasonally, it becomes difficult to pool economic value data over years. Like LER for intercropping experiments, cost benefit ratio (CBR) for individual rotation could be used for analysis.

Because of natural calamities, some times one or two crops of the rotation or entire experiment are likely to give poor yields or erratic results are observed due to change in weather conditions. Special efforts are required for the analysis of such data. Use of repeatability concept in analysis of rotation experiments needs to be studied. Crop rotation should be such that it should not deteriorate crop as well as soil productivity, rather it should be environmentally friendly and improve it. Stability concept can help in analysing such situations and there by help in proper recommendation of the suitable rotation.

5. Statistical Aspects of Different Cropping Systems - Multiple Cropping and Rotational Cropping

P.B. Parthasarathy*

Multiple regression analysis is generally used to assess the productivity of resources in crop production either individual or crop combination. Several types of production functions were tried by many research workers but the Cobb-Doughlas type of production function was found most suitable for economic analysis. Several importaint economic measurements can be obtained from this function viz., (i) the type of returns to a given factor, (ii) the type of erturns to scales, (iii) the value of the marginal product of a given factor, and (iv) statistical adequacy of data. A critical review of the earlier studies revealed that mostly these works were confined to single crop enterprises rather than multiple cropping sequences. As such, there is need to undertake studies to assess resource use efficiency on different crop sequences sizewise, locationwise and under different farming situations like irrigated and rainfed.

Studies that help highlight the cost economics in farming are of value to farmers as well as for policy planning in agriculture. Towards that end, empirical research in cost funtions with particular reference to agriculture is a long felt need especially in the face of rising input costs with the advent of new technology and unremunerative product prices. The research undertaken in statistical cost functions in agriculture has confined only to single crop enterprise but not to different crop sequences in multiple cropping leading to lack of information about the nature and behaviour of costs and cost curves in different cropping systems.

The technique of linear programming (LP) has been widely used for resource use optimization and crop combinations within the multiple cropping systems

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and mixed farming systems. In terms of methodology development and application for analysis of different cropping systems, LP requires consistency in establishing an objective function and the technique is applicable only when an economic enterprise can identify one good objective such as maximising the profit or minimising the cost or loss. To this end, various studies have been undertaken in the country pertaining to evolve optimum crop combinations in a multiple cropping system to maximise net farm income or to maximise farm income through optimal enterprise combinations in mixed farming systems. One of the major limitations of the past studies is that they concentrated on the scope for enterprise reorganization.

The basic argumet of Multiple Objective Analysis (MOA) is that the decision makers are in reality engagd in the pursuit of several objectives and the traditional paradigam of unidimensional objective criterion approach is inadequate for dealing with such situations. Several authors have classified approaches to multiple criteria decision making in several ways. The pros and cons of most of these approaches as also the multiple criteria decision making in farm planning have been discussed at length in the literature. If the decision maker must take a decision within a environment of multiple goals, then goal programming approach is to be considered. This is accomplised by minimising the deviations among the desired levels of targets and the actual equalities through the addition of positive and negative deviational variables permitting either the under or over achievement of each goal. When the decision maker faces an environment of multiple objectives the approach to be considered is multi-objective programming. The first stage here is to generate the efficient set of solutions. That is, to seperate the pareto optimal feasible solutions from the nonpareto optimal ones. The second stage consists in searching for an optimum compromise for the decision maker among the efficient solutions. To undertake that stage it is necessary to incorporate in one way or another the preferences of the decision maker. Finally, if the environment within which the decision maker must take his decision is characterised by several attributes the approach to be considered is multi-attribute utility theory.

6. Experimental methodology for Agroforestry Research

C.K. Ramanatha Chetty*

Any design chosen for an experiment should enable the experimenter to achieve its objectives. Secondly, the design should be 'resource efficient'. This is very important in the context of Agroforestry (AF) experiments.

The main aim of Multi-purpose tree (MPT) trials is to collect information on the performance of species/provinances for definite land use functions. This

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trial may be done in stages such as (a) survival trials, (b) establishment trials, (c) phenology trials, and (d) continuing management trials. The number of species/provenances to be included in a trial are important for deciding on the experimental design. If the species are many, Incomplete Block Designs are suitable. Another way is to divide the species into several groups based on the potential uses of the species and carry out smaller experiments for each group.

Selection of plot size is an important issue in all AF trials including MPT trials. Large plot size often introduces larger variation in both soil and management characteristics. An alternative is to consider plots with single line or single tree, but the effective experimental area will be small. If agronomic treatments such as spacing or management aspects such as pruning/cutting heights are integrated in MPT trial, systematic designs such as parallel row designs are available, but their utility is limited.

Tree-crop interface studies are important for better understanding of the tree-crop interactions. Alley cropping or Hedge row intercropping is one way of such investigations. In these experiments both trees and annual crops exist at the same time. More popular trials among agroforestry research workers pertain to a situation when continuously grown closed spaced, heavily pruned rows of woody species are tested along with the annual crops within the alley ways. When trees are not closely spaced, the micro effect of each of the tree on the surrounding annual crop is of interest. In such situations circular systematic design can be conveniently superimposed over the larger experiment. Alley cropping experiments require large plot size. Thus even though the numbe of treatments is small, the block size becomes too large leading to very high values of C.V. One should therefore search for a resource efficient design. In this context, a partially systematic design called HAHA design has been introduced. Though these are resource efficient designs, their analysis is rather intricate as they involve non linear regression/iterative proceedures requiring a trained biometrician with powerful computer hardware and special software in his kit. In regions having low rainfall, it may be worthwhile considering to introduce a fallow period in relation with available crops so that hedgerow is allowed to grow as a tree fallow which may help in ameliorationg soil fertility. A study may, therefore, be undertaken to arive at the optimum lengths of the cropping and fallow periods. In addition hedgerow treatments such as spacing/geometry/lopping can be clubbed.

The agro-horticultural experiments are different from hedgerow intercropping investigations. The trees in a row are seperated by a few meters space in the former while they are closely planted in the latter. Here, apart from soil and environmental heterogeneity, there will be heterogeneity due to difference in tree dimensions. There is a possibility of achieving better homogeneity of blocks by grouping the trees which are similar to form the blocks which need not be physically contiguous. Even in these agro-horticultural studies, rotation of crops with fallows can be introduced and its effect on fruiting of trees etc. noted.

Any AF system, prima facia, has several objectives and yields many products and services all with different values and functions. Sometimes benefits such as soil and moisture conservation are difficult to be quantified for ranking treatments in AF research. Therefore, there is no single way to assess the results from these trials. Assessment methods include calculation of LERs and economic analysis, apart from straight forward analysis of yields of biomass or protein content of fodders, etc. Sufficient care is to be taken in (a) choosing suitable samples for measurement from experimental plots, (b) converting measurements to per hectare basis, (c) evaluating multiple outputs, and (d) extending evaluations over many cropping seasons.

7. Design and Analytical Techniques for the Tree Based Farming Systems

U.M. Bhaskara Rao*, K.P.R. Vittal*, S.K. Das* and J.C. Katyal*

Tree based farming systems some what relate to intercroping. At the same time, being perennial in nature and with multiple output components, it differs a lot from it. The problems in tree based cropping systems are many. They occupy larger area and secondly genetic variability of the tree species is high. Under rainfed agriculture the soil heterogeneity, is another problem. Therefore, statistical techniques for evaluation of tree based farming system under varying spatial and temporal effects are challenging. The experiences on closely packed tree rows with alleys, widely spaced tree rows with alleys and their effects on crops in tree based farming systems at CRIDA under rainfed conditions are discussed.

Soil based experimentation for evaluating a tree components: Bounds were made as per soil conservation requirement on the *toposequence.* A replication is fitted in each terrace. Depth of the pit was taken as auxillary variate to form blocks. Blocking efficiency can be further increased by considering more auxillary variables like clay content etc.

Evaluation of optimum geometry for tree planting: A systematic design was used to find out the optimum geometry of planting *Jatropha* species. The spacing varied from 0.5 to 5.0 m with0.5 m stepping. A 33 m^2 design of this provided two replications for each geometry except square. 55 geometries are being evaluated with this design. A mirror image of this provided additional replications and took care of multiple slope effects.

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Evaluation of tree × crop interaction in alleys: In the case of widely spaced trees, to avoid confounding due to border effect or due to soil heterogeneity, concentric planting of annual crop may be follwoed around a single tree. Determine atleast three distances of planting from the tree. Select trees of same age with comparable appearance of height, diameter and foliage. Plant the annual crop around the tree. The first circle may be with a radius of 1 and next circles with (1+d) or (1+2d) radius, d being the recommended row spacing for the crop. By keeping the same plant to plant distance in any circular row, the area per plant is constant. The effect of tree on the crop can be judged from per plant yield from each row. By conducting the experiment with different age/size of tree, its effect on the companion crop can be determined.

In the case of closely spaced trees, plant the agricultural crops at their recommended spacing in between the two rows of the trees. Number the rows of agricultural crop with reference to the tree row. Record biometrical observations and harvest the crop row-wise. Plot of the row yield of the crop against the distance from the tree row indicates the amount of advantage/disadvantage.

Effect of treatments on tree species in alley: A modified randomised block design was developed for this study. The modified design is more efficient than the conventional one at all block sizes. The error mean square suddenly jumps when the treatments are increased from 8 to 16. Similar technique was used in widely spaced leucaena leucocephala and other fuel-cum-fodder trees.

Analysis of output obtained from agro-forestry systems: Data from tree componet requires to be dealt with over a long period of time. The yield (fruit, fibre, timber, fuel, fodder etc.) and the experimental errors in one season are not independent of those of another season. This difficulty could be overcome by analysing cumulative total yields (output) in successive seasons. But if the analysis is needed for each year, either analyse cumulative total yield upto a given season or use analysis of covariance with the previous year's yield as a concommitant variable.

Evaluation of multiple systems for long term sustainability : The objective of this experiment is to give best system of crop planning based on land capability. firstly, there is need to evaluate each system and inter se comparison of these systems. Secondly, evaluation of treatments imposed on arable cropping and tree component. There are many statistical problems in this experiment. There is a need to study the optimum plot size and sample size to estimate the production. Analytical techniques need to be developed to combine the results over seasons and inter se comparison of the systems. Sample sizes to estimate the soil physico-chemical changes due to the different systems need to be determined. Linear programming could be adopted to arrive at optimum cropping system planning.

Symposium on Improvement of Livestock Statistics

Chairman : Prof. C. Raja Reddy,
University Head, A.P.A.U.,
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Convener : Dr. O. P. Kathuria,
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At the outset, Chairman stressed the importance of livestock and poultry in the development of rural economy of the country. The availability of reliable statistics on livestock and poultry numbers and on the production of livestock products and their rearing and management practices is essential for immplementation of livestock development programmes. The papers presented at the symposium covered important areas like contribution of livestock sector to national income, present status of livestock products, statistics on feeds and fodder etc. The following recommendations emerged out of the papers presented at the Symposium.

1. A number of problems exist in the implementation of the methodology being followed in the integrated sample surveys for estimation of production of various livestock products and cost of production of livestock products. These relate to sampling, weighment/measurement of the product, data collection in the field etc. Suitable remedial measures are needed to overcome these problems.

2. While the integrated sample surveys provide estimates of major livestock products, there are a large number of by-products on which data are needed for filling the gap for national income estimation. Suitable action is needed for estimating the production of these by-products either through the existing surveys or by planning new surveys in these areas.

3. Data available from secondary sources may be used to supplement/validate the results obtained from primary data.

The extended summaries of the papers presented at the symposium are as follows.