



ABSTRACTS OF PAPERS

1. Unbiased Regression Estimators in Finite Population Sampling

B.V.S. Sisodia and K.K. Mourya

Micky (1959), William (1962), and Singh and Srivastava (1980) provided some sampling schemes, which yielded regression estimators of population mean in finite population sampling. The variances of the estimators were, however, quite complicated and faced computational hard-work. A new sampling scheme is proposed in the present paper, which is quite simple and provides an unbiased regression estimator. Its variance is derived which is simple one and is easily comparable with the usual biased regression estimator. An empirical study is also carried out to illustrate the precision of the unbiased regression estimators.

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2. Estimation of Population Mean under Non-Response in Two-Occasion Rotation Patterns

G.N. Singh and Jaishree Prabha Karna

The present work is an attempt to study the effect of non-response at both occasions in search of good rotation patterns over two occasions. Ratio type estimators have been proposed for estimating the population mean at current occasion in presence of non-response at both the occasions in two-occasion successive (rotation) sampling. Detailed behaviors of proposed estimators have been studied. Proposed estimators are compared with the estimator using no information from previous (first) occasion. Performances of the proposed estimators have been demonstrated via empirical studies.

Indian School of Mines, Dhanbad

3. On the Precision of Ratio Estimators using Linear Transformation

Sunil Kumar, Amar Singh and B.V.S. Sisodia

Various authors have proposed different version of linear transformation of the auxiliary variable (x) in

sample surveys to reduce the bias and mean square error (MSE) of usual ratio estimator. Notable among them are Mohanty and Das (1971), Reddy (1974), Srivenkatramana (1978), Das and Tripathi (1980), Sisodia and Dwivedi (1981), Singh and Kakran (1993), Mohanty and Sahoo (1995), Upadhyay and Singh (1999), Swain (2009) etc. A comprehensive review of transformed ratio estimators is presented in this paper. Moreover, when a prior value of y -intercept in the simple linear regression of y on x is available, a linear transformation of study variable y is suggested to find out another modified transformed ratio estimator. Following Swain (2009), a linear transformation of x based on minimum and maximum values of x is also proposed and accordingly another new transformed ratio estimator is developed. Properties of proposed modified transformed ratio estimators are studied. An empirical study with some real populations is also carried out to highlight the precision of transformed ratio estimators.

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4. Comparison of Ratio Estimators with One Auxiliary Variable using Monte Carlo Simulation

M. Krishna Reddy¹ and K. Ranga Rao²

Ratio estimators are often employed in sample surveys for estimating the population mean \bar{Y} of a characteristic of interest Y or the population ratio

$\frac{\bar{Y}}{\bar{X}}$ utilizing a supplementary variate X that is positively correlated with Y . It is well known that the classical ratio estimator $\frac{\bar{y}}{\bar{x}}$ is biased and often, in practice, the

bias may be negligible compared to standard error and can be neglected. In recent years, considerable attention has been given to the development of unbiased and almost unbiased ratio estimators. The classical ratio estimator, two unbiased and two almost unbiased

estimators available in literature in this paper and are compared with respect to relative bias, mean square error, skewness and kurtosis using Monte Carlo simulation by generating random samples from different bivariate population with known correlation coefficients. The Monte Carlo simulation is adopted for comparison of these ratio estimators because analytical comparisons are not possible.

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5. Allocation in Stratified Sampling using R-Software

S. Maqbool¹, Mahesh Kumar² and S.P. Singh²

Stratified sampling techniques have been widely used for surveys because of their efficiency. The purpose of stratification is to partition the population into disjoint sub-populations so that the power consumption characteristics within each sub-population are more homogenous than in the original population. In this paper, we have developed computer programs in R-Software which can be implemented for allocation problems using equal and proportional allocation methods and also for drawing inferences of related parameters.

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6. Robust Estimation in Finite Population Sampling

R.P. Kaushal and B.V.S. Sisodia

Following Scott *et al.* (1978), a BLU predictor of population total under the model $\xi(0, 1 : x_{hk}^2)$ in stratified sampling when the slope of the model is common across to strata is constructed. Its robustness and optimality is studied when some general polynomial model of degree J , i.e. $x(d_0, d_1, \dots, d_J : x_{hk}^2)$ is true in real practice. It has been found that the proposed predictor is robust and optimal for stratified balanced sample and is also more efficient than that of due to Scott *et al.* (1978) when slopes are varying from stratum to stratum.

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7. Secondary Stage Education in India: An Analytical Overview

Virendra P. Singh¹ and Sandeep K. Sharma²

The present study has analytically overviewed the secondary stage education based on the recent past educational surveys. It provides tangible comparisons pertaining to secondary stage education on the schooling facilities in rural areas, schooling facilities in habitations predominantly populated by scheduled castes and scheduled tribes, schooling facilities in villages, secondary schools, secondary sections in the schools, enrolment in classes IX and X, science laboratories and computer education, guidance services, pre-vocational courses, secondary stage in oriental schools following general system of education, schools admitting children with disabilities and enrolment taking place in India. The study utilizes secondary data collected during recent successive two surveys, namely, sixth and seventh on school education conducted by the National Council of Educational Research and Training under administrative and financial control of the Government of India.

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² Indian Agricultural Research Institute, New Delhi

8. Some Statistical Aspects on Major Operational Incentive Schemes in Indian Schools

Virendra P. Singh

This paper considers some statistical aspects on major operational incentive schemes prevailing to attract children in the Indian schools. Attempts have been made to analyze the availability of major incentive schemes in the schools covering incentive schemes on free uniforms, free textbooks, supply of free textbooks, attendance scholarship for girls and beneficiaries thereof by social groups, namely, scheduled casts, scheduled tribes, educationally backward minority community, respectively including midday meals and types thereof at primary stage in the country. The present paper is based mainly on secondary data on school education collected during seventh school education survey conducted by the National Council of Educational Research and Training under administrative and financial control of Government of India.

National Council of Educational Research and Training, New Delhi.

9. Estimation from Independent Sub-samples of a Population

Jagbir Singh

In this paper Minimum Variance Linear Unbiased Estimators for population mean (i.e. milk yield/day) in the first year, second year and third year; change and average thereof over years thereof have been developed by making use of Projective Geometry approach and adopting the following sampling design: In a district, two independent sub-samples of villages are drawn with simple random sampling without replacement of size n_1 and n_2 respectively. Next year m_1 and m_2 sample villages are retained in sub-sample 1 and 2 respectively and u_1 and u_2 sample villages are drawn using SRS without replacement. Here $n_1 = m_1 + u_1$ and $n_2 = m_2 + u_2$. In the third year m_1 and m_2 sample villages are replaced by another set of villages using SRS without replacement, while u_1 and u_2 sample villages remain unchanged. In each selected village out of H , h households are selected and in each selected household two cows in milk are selected using SRS without replacement for collecting information on milk yield/day.

Indian Agricultural Statistics Research Institute, New Delhi

10. A Note on Variance Estimation of Ratio Estimators in Two Phase Sampling

R. Arnab¹ and U.C. Sud²

An alternative estimator of the variance of the ratio estimator under two phase sampling scheme has been proposed. The proposed variance estimator is approximately unbiased and more efficient than the existing classical estimator due to Cochran (1977) and Rao-Sitter (1995) under a linear superpopulation model with intercept.

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11. Some Investigations on Sampling Variance of Genetic Correlation

S.D. Wahi and A.R. Rao

The present investigation is an attempt to compare the estimated, predicted, empirical and bootstrap standard errors for different combinations of population heritability, genetic and phenotypic correlation for different family sizes and structures under half-sib

mating design. The data under half-sib model are simulated by taking sire effects following normal as well as gamma distribution. It is observed that the empirical standard error of genetic correlation when sire effects are from gamma distribution are invariably higher as compared to the data with sire effects following normal distribution irrespective of the sample size heritability and genetic correlation of the traits. The empirical standard error of genetic correlation estimates are very high for lowly heritable traits for whole range of positive and negative genetic correlation. The large sample approximation of standard error given by Tallis is always underestimating the standard error even for large family size of 30 to 50 and should not be used in practice.

Barring small sample size the bootstrap estimates of SE are very close to predicted SE and can be used as an estimate of SE of genetic correlation. The bootstrap estimates of standard error of genetic correlation are found to be very close to the predicted standard error for sample size 500 and above in case of lowly heritable traits for both positive and negative genetic correlation values. In case of moderately and highly heritable traits the bootstrap estimates of standard error are found very close to predicted standard error for all values of genetic correlation and for all the sample sizes and family structures expect for sample size 200 (10, 20) in case of moderately heritable traits. Hence, it can be said that the bootstrap estimates of standard error which are very close to predicted values can be used to estimate the standard error instead of approximate formulae given in literature. It is also found that in case of non-normal data sets with sire effects following gamma distribution the bootstrap estimates of standard error of genetic correlation are always underestimated.

Indian Agricultural Statistics Research Institute, New Delhi

12. Growth Pattern and Current Scenario of Pulse Production in Uttar Pradesh

M.K. Sharma and B.V.S. Sisodia

The Uttar Pradesh is most populous state of the country. It accounts for about 12 per cent (2003-04) of total area of pulses while 16 per cent (2003-04) of total pulse production in the country. The average yield of

pulses has been between 7.00 to 9.29 quintal per hectare since 1987-88. However, the area under pulse crops has declined substantially over years to the extent of 2.7 million hectare in 2003-04 from 3.0 million tonnes in 1987-88. Similarly, the scenario of pulse production has also not been satisfactory since it has witnessed tremendous fluctuations ranging between 2.36 to 2.62 million tonnes since 1987-88.

Uttar Pradesh has four regions i.e. Western, Central, Bundelkhand and Eastern regions. This study is based on the different regions of Uttar Pradesh having important role in term of pulse production. Various statistical tools used to determine the growth rates, instability of variation of area, production and productivity of different pulse crops and total pulse crop for two different periods before and after the launch of technological mission on pulse production in the country.

The growth rate, sustainability etc. on area, production and productivity of pulse crops of U.P. have been worked out. The time series data pertaining to 1960-61 to 2005-06 have been considered, which has been divided into two periods, before (1960-61 to 1989-90) and after (1990-91 to 2005-06) launch of Technology Mission on pulse production. The pulse crops i.e. arhar, pea, gram and lentil alongwith total pulses were taken for the study. It has been found that the area of pea of Bundelkhand region have been more stable in pre technology mission. The same trend follows in the case of production. Increase or decrease in area and production of different regions have been carried out over different decades. The overall results indicate that the Bundelkhand region has been found more stable in respect of all the pulse crops considered under study.

N.D. University of Agriculture & Technology, Faizabad

13. Measurement of Risk in Yield of Cotton in Amravati Division

P.D. Deshmukh, R.K. Kolhe and A.S. Tingre

The study was conducted to measure the risk in yield of cotton in Amravati division of Vidarbha region over a period of 30 years. In general, for overall period

(1975-76 to 2004-05) growth rates of production and yield of cotton were positive and highly significant. Constant variability in area of cotton were observed for all the districts under study as well as for Amravati division as a whole. In overall period lowest probability of crop failure were observed in Yavatmal district (0.56) with crop loss ratio of 22.20 per cent. The yield uncertainty arising due to vagaries of nature vitiates farmers production programme and causes instability in production and income of the farmers.

The measurement of risk involved in crop production is of paramount importance to suggest remedial measure of technical and social nature. Keeping in view the above aspects it is proposed to measure risk involved in the production of cotton crop of Amravati division of Vidarbha, which is the major Cotton growing area of the Vidarbha region of Maharashtra. Presently cotton is a backbone of Maharashtra's economy Maharashtra state ranks first in the country as regards to the area of 27.60 lakh ha. under cotton with production of 271 kg. lint / ha. Vidarbha region has about 65 percent of the total area under cotton in Maharashtra i.e. 12.50 lakh ha. with the production of 24 lakh bales and productivity of 326 kg lint / ha. The study was undertaken with the following objectives:

- (1) To examine the growth and variability of cotton.
- (2) To measure the risk in yield of cotton.

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

14. Statistical Evaluation of Socio-economic Development of WSHGs through Aquaculture Activities in Keonjhar and Koraput Districts of Orissa

Nirupama Panda¹ and K.B. Dutta²

Aquaculture is an economic, employment generating and developmental activity for women self-help groups. Koraput and Keonjhar are two tribal dominated districts of Orissa and are inhabited with more than 76% of households living below poverty line. The present study was conducted to statistically evaluate the socio-economic development of the members of the women self-help groups undertaking aquaculture activities in these two districts. Seventeen developmental indicators common to all the WSHGs were considered for analysis. The composite indices of development for the WSHGs in three dimensions e.g.

economic, social and empowerment along with the overall development index have been estimated. On the basis of the level of development, the WSHGs were classified into four categories of development e.g. high level, high middle, low middle and low level.

It is revealed from the study that most of the WSHGs have developed to the stages of high middle and low middle level of development through aquaculture activities. The members of the WSHGs were empowered to a higher level (Composite Index = 0.37) compared to economic development (Composite Index = 0.56) and social development (Composite Index = 0.64) during the year 2008-09. The correlation coefficient between the composite index of overall development and composite index of social development was highest ($r = 0.89$) and the correlation coefficient between economic development and empowerment was the lowest ($r = 0.04$).

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15. Poultry Egg Production in India

Shiv Prasad¹, Rajendra Singh¹ and D.P. Singh²

Poultry is a part of our livestock and provides protein in the form of meat and eggs. The fowls and ducks contributed 93.54% and 6.21% to total poultry population (489.01 million) in the year 2003. About 1832 million eggs were produced in 1950-51 and increased to 53532 million eggs in 2007-08 with 6.10% annual growth rate so that the availability of eggs per head per year increased from 5 eggs in 1950-51 to 51 eggs in 2007-08. The fowls and ducks contributed 94.69% and 2.88% respectively to total egg production during 2006-07. The average annual egg production of improved fowls (250) was higher than Desi fowls (90) and ducks. Andhra Pradesh and Tamil Nadu ranked first and second with respect to annual egg production. Different growth functions viz. linear, quadratic, non-polynomial, exponential, logistic and Gompertz were fitted to total egg production from 1950-51 to 2007-08. On the basis of different measures of goodness of fit, exponential model was found the best to describe the egg production curve.

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16. Some Investigation on the Statistical Properties of Goodness of Fit Criteria of Non-linear Growth Curves through Bootstrap Technique

A.K. Paul, Mohan Das Singh and S.D. Wahi

The three non-linear growth models that are Logistic, Gompertz, and Von Bertalanffy have been considered to investigate the statistical properties of goodness of fit criteria. The monthly body weight data from birth to 12 months age on 110 animals obtained from CIRG goat farms, Makhdoom, Uttar Pradesh for the year 2005 has been used for study. The bootstrap samples are drawn with replacement from this data to obtain statistical measures of the goodness of fit criteria like R^2 , RMSE and ARR of all the three growth models. The statistical analysis based on the bootstrap samples shows the non normal distributions of these criteria. The overall mean value of RMSE is 0.7876 with standard deviation 0.0267 and overall mean value of ARR is 32.2067 with standard deviation 3.1833 are found least in case of Von-bertalanffy model. So, among the three models studied the Von bertalanffy model comes out to be the best model to describe the growth pattern goats.

Indian Agricultural Statistics Research Institute, New Delhi

17. Market Integration in Coarse Cereals in India: A Case of Maize and Jowar

Prawin Arya, A.K. Vasisht, Sivaramane N. and D.R. Singh

Coarse cereals, being the staple diet of millions of poor people of India play a very important role in maintaining their nutritional status. However, due to change in per capita income and subsequently the dietary pattern, there is a gradual shift in consumption from coarse cereals to major cereals such as rice and wheat. Due to the imbalances in the production performance of different crops and relatively poor performance or stagnation of the important coarse cereals along with wide fluctuations in prices, the coarse cereals are decelerating at a very fast pace. Several studies have elucidated factors such as poor demand, rise in the per capita income, increase in irrigated area, and increase in the relative output prices in favour of major cereals, and market imperfections as the major reasons for this shift. In this backdrop, this study has been conducted to investigate spatial integration of Maize (*Zea mays*) and Jowar (*Sorghum bicolor*) markets in India. The multivariate

cointegration methodology using Johansen's procedure was used to study the extent and nature of cointegration among the maize and jowar markets. The time series data pertaining to the period Jan. 2001 to Dec. 2008 on the wholesale prices of sixteen maize markets and eleven jowar markets were used for the analysis. The data were screened to impute the missing values and to remove the outliers. Further, the data was transformed by detrending and deseasonalizing. The results showed that the nine jowar price series and twelve maize price series were non-stationary and were integrated of the first order. The maximum eigen value and trace tests showed that there were six and five cointegrating vectors for jowar and maize markets respectively revealing reasonably good degree of integration among markets. The series though integrated in the longrun had shown disturbances in the shortrun. The ECM showed the pace of adjustment of the shortrun disturbances towards the longrun equilibrium.

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18. On Methods of Estimation of Generalized Negative Binomial Distribution

Abhay Kumar¹, R.C. Bharati¹, S.K. Singh², A. Mishra², and K.M. Singh¹

The negative binomial distribution was perhaps the first probability distribution, considered in statistics, whose variance is larger than its mean. On account of wide variety of available discrete distributions, the research workers in applied fields have begun to wonder which distribution would be most suitable one in a particular case and how to choose it. With the aim of reducing this problem, Jain and Consul (1971) gave a Generalized Negative Binomial Distribution (GNBD) by compounding the negative binomial distribution with another parameter which takes into account the variations in the mean and variance. This GNBD reduces to the binomial or the negative binomial distribution as particular cases and converges to a Poisson-type distribution in which the variance may be more than, equal to or less than the mean, depending upon the value of the parameter. A number of methods for estimation of parameters of GNBD, like weighted discrepancies method, minimum chi-square method etc. are available but these methods produce such equations which are not simple to be solved directly and hence some iterations has to be applied to find the solution.

An alternative estimator has been suggested here, which is capable of giving more or less as good results as given by the moment estimators. Although, the probability of the observed value of χ^2 to be exceeded, are slightly higher in case of the suggested method than in case of method of moments, these differences do not seem to be much significant and can be considered due to sample fluctuation. Further, the suggested method has one definite advantage over the other methods in certain situations. It can be applied when the method of moments fails to give estimates of the parameters. Moreover, it is relatively very quick to be obtained and so it may be preferred to others where very quick results are required.

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19. Growth Pattern and Technological Impact of Oilseeds Production in Uttar Pradesh

A.K. Bharti, L.K. Dube, B.V.S Sisodia and M.K. Sharma

An attempt was made in present investigation to find the trend and growth rates and the impact of Technology Mission on Total oilseeds including the oilseeds crops i.e. groundnut, rapeseed-mustard and linseed. The time-series data on area, production and productivity of oilseeds crops and total oilseeds in Uttar Pradesh pertaining to the period 1970-71 to 2005-06 were used for the investigation of trend and growth of oilseeds and also impact of technological changes on oilseeds production in the state of Uttar Pradesh. The relevant statistical tools & technique like regression analysis etc. have been used for the purpose of investigation.

An attempt was also made in present investigation to fit the parametric & nonparametric regression models to arrive at a methodology that can precisely estimate the trend and growth rates in area, production & productivity of rapeseed-mustard crops grown in different agro-climatic zones of U.P. For a period of 36 years time-series data from 1970-71 to 2005-06 on area, production and productivity of rapeseed-mustard crop of the U.P. were collected. In the case of parametric models, first, second, third degree polynomials, exponential and Gompertz models were considered. The statistically most suited parametric models were

selected on the basis of adjusted R^2 , significant partial regression coefficients and significant coefficient of determination (R^2), Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) values and assumptions of residuals. The statistically sound model was selected on the basis of various goodness of fit criteria viz. RMSE, MAE and assumptions of residuals (Shapiro-Wilk test for normality and Ljung & Box test for randomness). Relative growth rates of area, production and productivity of the rapeseed-mustard crop were calculated for the successive years starting from 1970-71 to 2005-06.

The results indicated that none of the parametric models were found suitable to fit the trend in area, production and productivity of the rapeseed-mustard crop under investigation due to either non-significant partial regression coefficients lack of assumptions of the residuals. Non-parametric regression model was selected as the best fitted function for the area, production and productivity of the rapeseed-mustard crop.

On an overall it can be concluded that increase in area in case of rapeseed-mustard & groundnut has made some breakthrough in their production. Increase in productivity of groundnut, rapeseed-mustard and linseed has also contributed to their production to some extent. The production of oilseed has however not been satisfactory in the State in terms of its productivity as well as production because there is still shortfall of our desired level of oilseed production. It has been also found that technological changes have made significant structural technological changes have made significant structural difference in the production process of rapeseed-mustard between two periods. More efforts should be made to concentrate on these crops besides rapeseed-mustard by the policy makers in the State.

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20. Family Size Distribution and Correlation Between the Numbers of Two Types of Children in Family: Evidence from Six African Countries

H.L. Sharma¹, R.N. Singh² and Roshni Tiwari¹

This paper is concerned with the investigation of the family size distribution as Polya-Aeppli distribution, truncated below one and computation of correlation

between the numbers of male and female children in a family. The distribution involves two parameters θ and q and these are estimated by methods of moments. The suitability of the distribution and correlation is tested using 10% sample of new DHS data gathered recently on six countries namely *Lesotho, Namibia, Kenya, Swaziland, Zambia, and Zimbabwe* related to Eastern-Southern sub-Saharan Africa. The observed and expected correlation coefficients are found to be significant and the same in each country. There is more variation in the estimated values of θ rather than that of q . The results reveal that the average family size mainly depends on θ , average size of groups per couple in a family, not on q . Through the values of χ^2 at 5% level, we deem the fit of the distribution to be very good. The values of the parameters of this distribution may be used to generate the underlying sibship sizes for the simulation study.

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21. Scenario of Fertilizer Consumption in Eastern Uttar Pradesh

Annu, L.K. Dubey and M.K. Sharma

Eastern Uttar Pradesh is the most populous and occupies an important place in fertilizer consumption in the state. It covers 25 districts. Spread over in three –climatic zones viz. North Eastern plain zone (NEPZ), Eastern plain Zone (EPZ) and Vindhyan Zone (VZ). The study is based on secondary data which was procured from Directorate of Agricultural Statistics and Crop Insurance covering the period 1970-71 to 2004-05. This paper has been prepared to study the aspect of fertilizer consumption during pre and post green revolution period along with trend of fertilizer consumption. The three yearly moving average methods used for smoothing of data and also finding the trend of fertilizer consumption. The different growth curves were used for growth rate of fertilizer consumption. The trend of fertilizer is very aggressive due to awareness of farmers. The year 1985-86 has been found to consume highest fertilizers consumption for all the zones. The eastern plain zone recorded highest growth rate in term of fertilizer consumption during green revolution whereas, North Eastern Plain Zone showed highest growth rate in post green revolution period. The study shows that there has been an abrupt increase in

growth rate in fertilizer consumption in Eastern Uttar Pradesh, which might be because of certain favourable conditions.

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22. **Balanced Block Designs for All Order Neighbour Correlations**

Anurup Majumder and Aatish Sahu

The work of Morgan and Chakraborti (1988) for optimality results for block designs under first and second order (NN1 and NN2, respectively) neighbour correlations has been extended for all order (NN t , where $t = 1, 2, \dots, k - 1$ and k is the block size) neighbour correlations. Conditions for optimality and minimality are presented for NN t model.

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23. **Forecasting of Arrivals and Prices in Ramnagar and Siddlaghatta Cocoon Markets**

R. Bharathi, Y.N. Havaladar, S.N. Megeri and G.M. Patil

The cocoon study was carried out to forecast the arrivals and prices of cocoon of Ramnagar and Siddlaghatta market. The main aim was to forecast the arrivals and prices of cocoon in both the markets. The data on price and arrivals of cocoon was collected for those markets from 1998-99 to 2007-08. ARIMA (Auto Regressive Integrated Moving Average) model was used for forecasting of arrivals and prices in both the markets. Suitable model was identified based on the ACF (Autocorrelation Function) and PACF (Partial Autocorrelation Function). The adequacy of the model was judged based on the values of Box-Pierce Q statistics and AIC (Akaike Information Co-efficient) and the accuracy of forecasts for both Ex-ante and Ex-post were tested by using MSE (Mean Square Error) and MAPE (Mean Average Percentage Error). The model (1,1,3) (1,1,1) was tentatively identified for arrivals and model (0,1,0) (1,1,1) was identified for prices of cocoon in Ramnagar market and model (2,1,1) (1,1,1) was identified for arrivals and (0,1,0) (1,1,1) model for prices in Siddlaghatta market. Forecasted values of arrivals showed increasing trend in both the markets and price showed decreasing trend in Siddlaghatta market.

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24. **Prediction Models for Consumption of Pesticide**

S.N. Megeri and R. Veena

A study was conducted based on the secondary data procured from the Agricultural Research, Data Book 2004 and Compendium of Environment Statistics, 2001, Central Statistical Organization, Ministry of Statistics and Programme Implementation & Ministry of Chemicals and Fertilizers, Govt. of India & Ministry of Agriculture, Govt. of India. Here we tried to find out the suitable models to predict the pesticide consumption in India and some of the southern states of India. For the present study 15 years data was collected on pesticide consumption in India and for southern states viz. Karnataka, Andhra Pradesh, Tamil Nadu and Goa. The result reveals that for pesticide consumption the best fitted models were linear and quadratic regression model with R^2 values 0.932 and 0.943 respectively for India. Similarly for Karnataka, Andhra Pradesh, Tamil Nadu and Goa also linear and quadratic regression models fits well. We noticed decreasing trend in the consumption of pesticides. This indicates that instead of using excessive chemical pesticides in various crops to control insect pests of the farmers are using alternative techniques of pest control like cultural, mechanical, biological methods and bio pesticides. Using the best fitted models we forecasted requirement of pesticide for next five years.

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25. **Forecasting of Rice (*Oryza sativa* L.) Production in Tamil Nadu by using Statistical Model**

Y.N. Havaladar, S.N. Megeri and K. Padmanaban

In this paper, an attempt has been made to forecast rice production using statistical time-series modelling technique— simple exponential smoothing. In Tamil Nadu the rice is the important crop among all crops. The study indicated that there is declining trend in production due to low rainfall and also the some of the rice growing sea shore districts are affected by natural calamities in 2003-04. Then introduction of some new rice growing technology and water management system, the production of rice growing increasing trend.

University of Agricultural Sciences, Dharwad

26. Forecasting Models for Fertilizer Consumption in India

S.N. Megeri and H.S. Anil Kumar

Long term fertilizer requirement and dependency are key to the success of long term plans for global food security and the profitability of the fertilizer industry. The production of nitrogen (*N*) and phosphorus (*P*) fertilizer together has increased from mere 0.3 lakh MT in 1950-51 to about 147 lakh MT in nutrients terms in 2001-02. The overall consumption of fertilizers in nutrient terms (*N, P & K*) currently is about 175 lakh MT per annum. Hence in the present study investigation is carried out, on *NPK* fertilizer consumption. It explains fertilizer demand in relation to net irrigated area and dry land area in India. The multiple regression was used to estimate the requirement of the fertilizer, it was noticed $R^2 = 0.97$ and is significant. With regard to fertilizer consumption over years different models were tried and cubic model was found best based on R^2 value followed by logistic model, power, linear and exponential model. Using the selected models the fertilizer consumption was estimated and also forecasted for next ten years.

University of Agricultural Sciences, Dharwad

27. Use of Discriminant Function Analysis for Forecasting Wheat Yield

Ranjana Agrawal, Chandrahas and Kaustav Aditya

Weather based modeling is one of the major approaches for forecasting crop yields. The approach utilizes time series data on weather variables and trend as explanatory variables. Mostly multiple regression technique is used taking trend along with weather variables as such or in some derived form or indices as regressors. The present paper deals with use of discriminant function analysis for developing wheat yield forecast model for Kanpur. Discriminant function analysis is a technique of obtaining linear / quadratic function which discriminates the best among populations and as such, provides qualitative assessment of the probable yield. In the present paper, quantitative forecasts of yield have been obtained using multiple regression technique taking regressors as weather scores obtained through discriminant function analysis. The time series data of 30 years (1971-2000) have been divided into three categories: congenial,

normal and adverse based on yield distribution. Taking these three groups as three populations, discriminant function analysis has been carried out. These discriminant functions have been used to obtain weather scores which have been used as regressors in the modeling. Various strategies of using weekly weather data have been adopted. The models have been used to forecast yield in the subsequent three years 2000-01, 2001-02, 2002-03 (which were not included in model development). The approach provided reliable yield forecast about two months before harvest.

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28. Comparison of Statistical Models for Rice Yield Forecasting

Y.A. Garde¹, A.K. Shukla¹, R.K. Sharma¹, S.K. Tewari¹ and S. Singh²

A study was undertaken for forecasting yield of rice crop based on time series data for 27 years (1981-82 to 2007-08) of yield and weather parameters obtained from G. B. Pant University of Agriculture and Technology, Pantnagar, District Udham Singh Nagar, Uttarakhand. To study the association between yearly crop yields and different weekly weather parameters, Karl-Pearson's correlation techniques were applied. For forecasting the yield of rice two statistical models were applied. It was found that proposed Modified Model-II based on technical and statistical indicators for forecasting the rice yield was better than Model-I of Agrawal *et al.* (2001). It was concluded that Model II may be effectively used for early pre-harvest forecasting of crop yield particularly up to two and half month before harvesting.

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29. Trends and Decomposition Analysis of Lentil in India

Hemant Kumar, Devraj and Purushottam

The growth in lentil area and production in the country has shown increasing trends. The study shows that the best trend in area and production is quadratic in nature. The significantly positive square term in the quadratic equation indicates acceleration in lentil area and production in the country during the study period.

Instability analysis shows that area and production of lentil remains almost stagnant during the classified periods. This variation indicates that stability in lentil area and production has not been obtained in the country. The present study highlights that the country as a whole showed significant growth rate in area and production of lentil during the period under study (1970-71 to 2006-07). Thus, further change in the lentil production in the country might be attributed to all the three effects i.e., area effect, yield effect and interaction effect. During the overall period, the change in the total production of lentil was completely due to the change in area under the crop as the yield and interaction effects were very small. Therefore, it is concluded that production growth in lentil over the past forty years has been slow and unstable with substantial temporal variation in the country.

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30. Forecasting Technological Needs in Genetics and Plant Breeding for Sustainable Agriculture

Ramasubramanian V., V.K. Bhatia, Amrender Kumar, Satya Pal and Sarvesh Kumar Premi

Technology Forecasting (TF) is the process of prediction of feasible or desirable characteristics of performance parameters in future technologies such as machines or techniques. TF methodologies range from intuitive (e.g. Delphi, Brainstorming) to statistical (e.g. trend extrapolation, growth models) to normative methods (e.g. relevance trees) and also include the scientometric methods. The domain of genetics and plant breeding has continued to evolve with a much broader scope and potential than in the past more so with incorporation of new knowledge from other fields of science. The conventional plant breeding programs can reduce the time frame for evolving new technologies if it takes full advantage of emerging fields like biotechnology. As a TF exercise, a Brainstorming session was organized at IARI, New Delhi which provided a platform to plant breeders, geneticists etc. in scripting the future technological needs of agriculture pertaining to the domain of genetics and plant breeding for converting the crop varieties/commodities into viable products for productivity improvement and effective utilization of modern tools for value addition and genetic enhancement. Information from experts was obtained through questionnaires for identification of specific technologies with greater utility which was then statistically analyzed for prioritizing future

technological needs. Attempts were also made to analyze the available information using multi-dimensional scaling approach.

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31. Monsoon and India's Rice Production - Rice Forecasting through ANN Modelling Methodology

S. Ravichandran

Artificial Neural Network (ANN) is an information processing system that roughly replicates the behaviour of a human brain by emulating the operations and connectivity of biological neurons. ANN modelling methodology is widely utilized for modelling time-series data and subsequent forecasting. Monsoon is the lifeline of Indian agriculture. Due to global climate change, monsoon also fluctuates. Indian sub-continent receives good rains in some years and fails to receive sufficient rainfall in remaining years due mainly to climate change. Modelling and forecasting all-India rice production is carried out by utilising data on all-India rice area, production and yield for the period 1950-51 to 2008-09 along with all-India rainfall data from June to September for the corresponding period. India, a monsoon dependent country, received one of the lowest rainfall (only 353 mm) during the peak monsoon months of June and July in the last 50 years. The previous lowest rainfall in June and July was during 2002-03 (306 mm), which happened to a severe drought year. Previous lowest June and July rainfall in some other years in the last 59 years are: 334 mm in 1972-73, 337 mm in 1987-88, 377 mm in 1982-83, 391 mm in 1962-63, 393 mm in 1965-66, 397 mm in 1979-80. Rainfall received from 1st June to 30th September, 2009 was 689.8 mm, which is 23% below the average rainfall. Based on the data for the period 1950-51 to 2008-09, several ANN models were developed using ANN models by making use of 70% of the data for training the model, 20% for testing and remaining 10% of data is utilised for validating the model. Forecasting was carried out by making use of the most efficient model. Based on the model, forecasting rice production for 2009-10 would be 82.19 million tons. This would be lesser by 16.9% compared to rice production during 2008-09.

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32. Implications of Global Warming on Agricultural Production in India

Sushila Kaul

Agriculture is vulnerable to global warming and the world's most widely eaten grains i.e. rice, wheat and corn are exquisitely sensitive to higher temperature. The impact of global warming on agriculture in developing countries, and particularly in countries like India, that depend on rain for irrigation, are likely to be devastating. Rice crop, in much of India will be affected by the global warming. Most of the hunger, resulting from global warming, is likely to be felt by those who are not responsible for contributing to the cause of the problem i.e. the people of developing countries. With climate change, the agricultural areas in the tropics will decline, causing a situation that those who are well off now will be better off in the future, and those who are in problems will be prone to greater problems. A rough rule of thumb developed by crop scientists is that, for every 1-degree Celsius increase in temperature, above the mid-30s, during key stages in the growing season, such as pollination, yields fall about 10 per cent. Optimum growing conditions for most of the crops, generally range from about 20 to 35 degrees, and then diminish sharply. At 40 degrees, heat stress causes photosynthesis to shut down. The climate change may erase all the gains that accrued, as a result of the technological advancements. The present study has been undertaken to assess the impact of climate related variables and agricultural production in India. For this purpose, two crops viz. rice and jowar have been selected. These two crops are predominantly grown in monsoon season and any change in climate, particularly rainfall and temperature would affect the productivity of these crops significantly. In the present paper an econometric model of crop production has been attempted. The analysis has been undertaken for the country as a whole, using state wise data for both these crops. For rice crop, the state of Orissa has been selected, because this is the main crop of the state. For jowar, the state of Karnataka has been selected, because of its significance in the region. Data on different variables for various states has been collected from the

publications of Directorate of Economics and Statistics, Ministry of Agriculture, as well as from the Economics and Statistics Directorates of various states. Similarly district-wise data has been primarily collected from the publications of these two state governments. The study reveals that excessive rains and extreme variation in temperature would affect the productivity of these crops adversely, thereby affecting the incomes of farming families in a negative manner. Thus suitable strategies pertaining to resource use, planting flood and drought resistant varieties of crops, better irrigation networks, and crop mix are to be adopted for mitigating the harmful effects of climatic changes.

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33. Growth Trends of Area, Production and Productivity of Rice (*Oryza sativa L.*) in Bihar

Mahesh Kumar¹, Manish Sharma², N.K. Azad¹, Nidhi¹ and S.K. Sinha¹

As rice is important staple food crop, its demand increases with increasing production. Looking to this important of rice crop in Bihar, an attempt has been made to study growth trend to rice regarding area, production and productivity data in Bihar. The 60 years data (1947-2007) were collected from Directorate of Statistics & Evaluation, Govt. of Bihar, Patna.

For this purpose data of 60 years is divided into two phases each with 30 years i.e. in first phase 1946-47 to 1976-77 and second phase 1977-78 to 2006-07. Further, phase first was divided into base period as 1946-47 to 1949-50 and current period as 1974-75 to 1976-77 phase second base period as 1977-78 to 1980-81 and current period as 2003-04 to 2006-07 by taking triennium average of each period in order to avoid fluctuations of year to year data. Further, the instability in area, production and productivity were calculated by using the coefficient of variation (C.V.).

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