

ABSTRACTS
(Poster Presentations)



Eighth International Conference on Agricultural Statistics
(18-21 November 2019)

PP1: Small Area Estimation using Data Integration from Two Survey with Different Data Strength
(Abstract Id: A1-1-077)

^aSadikul Islam, ^bHukum Chandra and ^cP R Ojasvi
^aAgricultural Statistics, ICAR-IISWC, Dehradun, India
^bSample Survey, ICAR-IASRI, New Delhi, India
^cHydrology and Engineering, ICAR-IISWC, Dehradun, India
sadikul.islamiasri@gmail.com, hcchandra12@gmail.com, projasvi@yahoo.com

Small area estimation has a serious challenge of small sample size, when data available through a single survey source. Many a time, two sample are collected independently from similar but different populations with same or different purposes. It is assumed that the first survey, small in sample size, collects both response variable as well as auxiliary variables and second survey, larger in sample size, has some auxiliary variables common to the first survey. Further, it is assumed that the auxiliary variables collected in the first survey only, has predictor variable that are available in both the survey. In this paper, a small area predictor for small area means are proposed by data integration from the two surveys. The performance of the proposed small area estimators are validated through two type of simulation studies namely, model-based simulations as well as design-based simulations.

PP2: Allocation of sample size in stratified SRSWOR design using separate ratio estimator under a superpopulation model
(Abstract Id: A1-1-016)

Dr. Bhuwaneshwar Kumar Gupta
Statistics, North Eastern Hill University, Shillong, India
bkgupt@yahoo.co.in

Allocation of sample size to strata is one of the major problems in stratified sampling. Optimum allocation involves unknown population parameters of the study variable which are substituted by the corresponding functions of related auxiliary variable in order to compute the allocation in practice. Hanurav (1965) and Rao (1968) were the first to use Superpopulation model approach to provide justification for the substitution. Gupta (2003, 2012) studied the problem using the approach for stratified Simple Random Sampling(SRS) designs using the usual unbiased expansion estimator (UEE). In this paper, the problem of allocation of total sample size to different strata is studied in stratified SRS design with separate ratio estimator (SRE) under superpopulation model approach. If SRS is used within each stratum, then the variance of the SRE for population total assuming large sample approximation contains strata variances of a transformed variable u which is the difference between the study variable y and product of the auxiliary variable x and stratum ratio R of strata totals of y and x . The stratum variance of the transformed variable u is a function of strata ratio R , strata variances of y and x and covariance between y and x besides stratum size and sample size. Thus all the quantities in the expression of SRE variance except the strata variances of the auxiliary variable x are unknown for which no intuitive estimates are available unlike in the case of UEE. The optimum allocation of fixed total sample size n which minimises the variance of SRE is proportional to the product of stratum size and stratum standard deviation of the transformed variable u . Thus the optimum allocation involves unknown parameters viz. strata variance of study variable and strata covariance of study and auxiliary variables. Therefore, it is not easy to compute workable optimum allocation as it appears because the stratum variance of u is too complex to speculate. Cochran (1977)

expresses the difficulty in the words, “ in the planning of a sample, the allocation with a ratio estimate may appear a little perplexing, because it seems difficult to speculate about the likely values of the stratum variance of the transformed variable u and suggested two rules”. However, no justification was provided for the suggested rules. Therefore, we seek to provide the justification under the usual superpopulation model considered by Gupta (2012). In order to compute the optimum allocation, some estimates of the stratum variance of u are needed. For, the model expectation of the variance of u is derived so that the same is substituted in place of the unknown variance of u in the optimum allocation to obtain the Model Optimum Allocation(MOA). The MOA under different approximations and assumptions gives rise to several quick approximations. All the model-based allocations are illustrated with two live populations and their efficiencies are compared. References: Cochran, W.G. (1977): Sampling Techniques, John Wiley & sons, New York. Gupta, B.K. (2003): Sample size allocation for stratified sampling under a correlated model, *Metron*, LXI(1)pp.35-52. Gupta, B.K. (2012): Allocation of sample size in stratified sampling under super population models. LAP Lambert Academic Publishing, Saarbrücken, Deutschland/ Germany. Hanurav, T.V. (1965): Optimum sampling strategies and some related problems Ph.D. thesis submitted to the Indian Statistical Institute. Rao, T.J. (1968): On the allocation of sample size in stratified sampling, *AIMS*, 20, 159-166

**PP3: Allocation proportional to strata total and linear phase effect
(Abstract Id: A1-1-044)**

Med Ram Verma

Division of Livestock Economics, Statistics and Information Technology, ICAR- Indian Veterinary
Research Institute, Izatnagar, Bareilly, India
medramverma@rediffmail.com

Stratified sampling is the most important sampling technique. Sample allocation is one of the important aspect of the stratified sampling. Impact assessment of the development programmes is one of the important aspect in socio-economic surveys. Selection of the proper sample size is essential for conducting the surveys for assessment of the impact of the development programmes. In the literature various suggested sample allocation methods for impact assessment of the development programmes. In the present paper we have proposed sample allocation procedures when sample size in each stratum is proportional to the strata total and linear phase effect. We have also considered the situation when the cost of observing the units varies from stratum to stratum. The proposed sample allocation procedures are general sample allocation procedures for assessment of development programmes. The paper concludes with empirical illustrations.

**PP4: An efficient class of ratio-product-ratio type estimators of finite
population mean in sample surveys
(Abstract Id: A1-1-078)**

^aDeepak Singh, ^bRohini Yadav and ^aHukum Chandra

^aDivision of Sample Surveys, ICAR-IASRI, New Delhi, India

^bDepartment of statistics, Amity Institute of Applied Sciences, Amity University, New Delhi, India
deepaksingh2112@gmail.com, ohiniya2016@gmail.com, hchandra12@gmail.com

This study proposes an improved class of estimators for estimating the population mean using available auxiliary information in sample surveys. The properties like bias and mean squared error have been studied under large sample approximation. The conditions have been derived for the suggested class of estimators under which it performs better than the sample mean, ratio, product, regression estimator, the two-parameter estimator proposed by Chami et al. (2012) and family of

estimators proposed by Singh and Yadav (2017). Under the empirical study, it has been shown that the suggested class of estimators performs better than some existing estimators.

**PP5: Disaggregate level crop yield estimation under spatial nonstationary hierarchical bayes small area estimation approach
(Abstract Id: A1-1-075)**

Priyanka anjoy, Hukum Chandra, Rajender Parsad and Kaustav Aditya
Agricultural Statistics, ICAR - IASRI, New Delhi, India
anjoypriyanka90@gmail.com, hchandra12@gmail.com, rajender@iasri.res.in, kaustav@iasri.res.in

In the light of a continual demand by Government and private data users Small Area Estimation (SAE) approach is becoming very crucial for providing finer geographic detail at various subpopulations or domain of interest. The use of valid statistical models is therefore necessary to obtain small area estimates with greater precision and reliability as compared to those traditional design based solution. Standard area level Fay-Herriot (FH) model is widely used model based option for aggregated level data, but in several applications presence of spatial effect between contiguous or neighbouring region cannot be denied and is not handled by FH model. Conditional Autoregressive (CAR) and Simultaneous Autoregressive (SAR) specifications do incorporate spatial associationship while taking into account the spatial correlation effects among areas. However, none of these approaches implement the idea of spatially varying covariates through spatially dependent fixed effect parameters. Such approach in statistics is known as Spatial Nonstationarity and require due attention to be employed in SAE field. This paper introduces spatial nonstationary version of FH model in a Hierarchical Bayesian (HB) paradigm. As a profound application paddy (green) crop yield is estimated at district level in the state of Uttar Pradesh in India using survey data from the Improvement of crop statistics (ICS) scheme and linked with Population Census. A considerable gain has been obtained while exploiting spatial information particularly through spatial nonstationary aggregated level small area model. In agricultural, environmental or health surveys spatial nonstationarity in the data are more commonly observed, therefore developed method can be recommended to improve the disaggregated level estimates.

**PP6: District level disparity in the level of institutional and non-institutional credit performance in agricultural households in the state of Bihar in India
(Abstract Id: A1-1-074)**

^aBhanu Verma, ^bHukum Chandra, and ^cDeepa Tyagi
^aGiri Institute of Development Studies, Lucknow, Uttar Pradesh, India
^bICAR IASRI, New Delhi, India
^cDelhi University, Delhi, India
bhanuverma502@gmail.com, hchandra12@gmail.com, deepatyagi12@gmail.com

In the situation of the credit flow in the state of Bihar, the majority of farm households do not have savings to invest in critical inputs such as irrigation, seed, fertilizer and agricultural chemicals. In recent past, the financial requirement of farmers has increased manifold due to adoption of modern technology. Loans are the only option which can help in increasing investment in agriculture through improving the liquidity of the agricultural households for using critical inputs at the proper time. Loans can be availed by two modes of credit sources, namely known as the institutional sources and the non-institutional sources. The institutional credit sources include loans availed by the source of government, co- operative society, banks whereas the non-institutional credit sources included the credit of loans availed by the source of employer/landlord, money lender, shopkeeper/trader,

relatives/friends and the other sources. Provision of credit to agriculture sector has been one of the main concerns of policy planners in India since independence. However, an assessment of the situation at ground level indicates that choice to non-institutional credit continues to dominate as far as agriculture sector are concerned. Institutional bankers perform a gap-filling function in Bihar whereas the situation is just reverse in other parts of the country. Among the major states in India, Bihar is at the lowest ladder in terms of proportion of institutional loan to total loan disbursement to farmers. The high indebtedness to money lenders may be an important reason for the indifferent attitude of farmers towards lending institutions, resulting in low investment and low productivity in Bihar. In the state of Bihar, non-institutional loans are availed by agricultural households almost five times than the institutional loan. It is important to note that in Bihar more than double agricultural households are availing non-institutional loans than the institutional loans at the richest level of living. Indeed, the state of Bihar, non-institutional credit is popular than the institutional credit irrespective of level of living. It is important to note that the state level estimates and related observations do not adequately capture the extent of geographical disparities within and between administrative units. In this paper, we use the All-India Debt and Investment Survey 2012-13 (AIDIS) and the Census 2011 for the State of Bihar and generated the district and district by different household category-wise estimate for proportion of agricultural households availing different sources of institutional and non-institutional credit. The results indicate that a huge variation in the distribution of sources of institutional and non-institutional credit between district and district by household category.

**PP7: Estimation of regression coefficient for survey data using calibration
approach and additional auxiliary variables
(Abstract Id: A1-1-049)**

Vandita Kumari, Hukum Chandra and Kaustav Aditya
Division of Sample Surveys, ICAR-IASRI, New Delhi, India
vandita.iasri@gmail.com, Hukum.Chandra@icar.gov.in, kaustav.aditya@icar.gov.in

The regression coefficients are often used to establish the structural relationship between the study and auxiliary variables. The ordinary least square (OLS) technique computes the regression coefficient under the assumption that observations are independently identically distributed (iid). However, survey data are complex in nature so the iid assumption may not be valid. As a result, the OLS estimates of regression coefficients can be inefficient for survey data unless sampling design is simple random sampling. The sampling weights, also referred as the design weights, are often incorporated in the estimation of regression coefficient for survey data to account for complex sampling design. The calibration approach is commonly employed in survey estimation to modify the design weights using auxiliary information to produce efficient estimator for the finite population parameters. This paper develops efficient estimator of regression coefficients by extending the calibration approach using available additional auxiliary variables. The estimators of variance of proposed estimators are also developed using two methods namely, analytical and resampling. The analytical method of variance estimation has been developed using Taylor series linearization method and the resampling method is performed using Bootstrap approach. The performance of the proposed estimators along with its corresponding variance estimators are evaluated through simulation studies. The simulation studies are conducted based on both the synthetic population as well as real population. The synthetic population is generated using assumed model to produce an artificial population whereas a real survey data-set is considered as real population. The empirical results based on simulation studies using both synthetic population and real data show that the developed estimators perform better than the existing estimator. Further, the empirical results reveal that both analytical and bootstrap variance estimators perform reasonably well.

**PP8: Improved two-step calibration of design weights in two phase sampling
(Abstract Id: A1-1-070)**

Saurav Guha and Hukum Chandra
Sample Surveys, ICAR-IASRI, New Delhi, India,
saurav.iasri@gmail.com, hchandra12@gmail.com

Survey data based on randomly drawn samples come with survey weights allowing valid inferences about the target population. Calibration weighting is a general technique for adjusting probability-sampling weights which incorporates auxiliary information to increase the precision of survey estimates. Given a probability sample with probability-based survey weights, calibration weighting involves a mild adjustment to those weights that forces the weighted totals for a set of calibration variables to equal values determined using more complete information whether from the target population itself or a larger sample. An improved two-step calibration of design weights in two phase sampling using two auxiliary variables is proposed. It is assumed that complete information is available for one auxiliary variable while information is not available for the other auxiliary variable. For a given sample, the calibration weights are set proportional to the design weights in the first step and in the second step, the constants of proportionality for different phases are obtained on the basis of different objectives of the investigator such as bias reduction or minimum mean squared error. Expression for bias and mean squared error are obtained for a large sample. Empirical evaluations using both model-based and design-based simulations are made with global estimators. An application of the proposed estimator with real life survey data is also discussed.

**PP9: Two-step calibration for estimation of finite population total under
two-stage sampling design
(Abstract Id: A1-1-063)**

Pradip Basak, Hukum Chandra and Kaustav Aditya
Division of Sample Surveys, ICAR-Indian Agricultural Statistics Research Institute, New Delhi, India
pradipbasak.99@gmail.com, hchandra12@gmail.com, kaustav.aditya@icar.gov.in

Auxiliary information is commonly used for efficient survey estimation. Calibration is a popular approach in survey estimation to produce efficient estimates of population parameter by incorporating auxiliary information. One of the assumptions of calibration approach is that the auxiliary variable is closely related to the study variable. Further, it is assumed that population aggregates of auxiliary variable such as population total or mean is known. However, many a times, such population aggregates of auxiliary variable is not available. Moreover, it may happen that there exists an additional auxiliary variable which is less closely related to the study variable, has known population aggregates. The additional auxiliary variable is assumed to be linearity related to the already existing auxiliary variable. Under such circumstances, information on both the auxiliary variables may be incorporated in the estimation process using two step calibration approach where auxiliary information is available at two levels. Here, we have developed efficient estimators of finite population total using two step calibration approach under two-stage sampling design. The result of the empirical evaluation using a real data based simulation study establishes superior performance of the developed estimators as compared to the existing estimator.

**PP10: Correlation and path coefficient analysis of grain yield and its growth
components in soybean (glycine max. l.)
(Abstract Id: A1-1-064)**

Agashe Nehatai
Department of Mathematics, Statistics & Computer Science, C.B.S.H., G.B.P.U.A.T, Pantnagar,

Uttarakhand, India
nehaagashe29@gmail.com

The object of study is to carry out correlation and path coefficient analysis for finding all possible relationships among grain yield and plant growth components (number of pods per plant, number of grains per plant, weight of grains per plant, LAI, plant height, number of branches per plant). Soybean (*Glycine max. L.*) is one of the important oilseed as well as a leguminous crop. The data on soybean crop was taken from field experiment which was carried out during the Kharif season of 2016-17 at the All India Coordinated Research Project on Weed Management, Department of Agronomy, Dr. P. D. K. V. Akola. The experiment was laid out in a strip plot design with three replications. Path coefficient analysis or simply path analysis is the special type of multiple regression analysis. Path coefficients indicate the direct and indirect effect of the variables on other variables. The various characters or components under study may have an association with each other that ultimately affect the yield. That association may be either in a positive or negative direction. The plant growth components are not only individually correlated with yield, but also correlated among themselves. The inter-character correlations among grain yield (GY), number of grain per plant (NG), number of pods per plant (NP), leaf area index (LAI), plant height (PH), weight of grain per plant (WG), number of branches per plant and biological yield (BY) are measured during this study. The study of correlation coefficient reveals that the number of pods per plant (649**), the number of grains per plant (592**) and the number of branches per plant (798**) are significantly correlated with grain yield. NP and NG are also highly correlated with other causal characters except for plant height which shows a non-significant result. WG, BY and PH show a non-significant result for grain yield. It is observed that the positive direct effects of number of pods per plant, number of grains per plant, weight of grains per plant, LAI, plant height, number of branches per plant and biological yield on the grain yield are 0.6942, 0.5912, 0.2270, 0.3522, 0.2678, 0.7970 and 0.1967 respectively. Among the causal characters, the number of branches per plant exhibits the highest direct positive effect (0.797) with grain yield. The indirect effects of NP, NG, PH, and NB on grain yield through other characters are observed to be positive. WT shows an indirect negative effect on grain yield through all other characters and LAI has also shown an indirect negative effect on grain yield through all other characters except BY which shows the positive indirect effect with lower magnitude. The indirect effect of BY on grain yield through other characters shows a negative effect except for LAI which has a positive effect on grain yield. Finally, it concluded that the number of grain per plant, number of branches per plant and number of pods per plant should be considered as indices for selecting high yielding soybean variety.

**PP11: On the adequacy of the sample sizes at different stages of sampling for
estimation of area, yield and production of food grain crops
(Abstract Id: A1-1-055)**

KK Tyagi
Sample Survey division, ICAR-IASRI, New Delhi, India,
kkanttyagi@gmail.com

In India, the estimation of yield rates of food grain crops is done on the basis of crop cutting experiments (CCEs) conducted in majority of States/Union Territories (UTs) under the National Programme of Crop Estimation Survey (CES). At district level, stratified multi stage random sampling design is used. Presently, around ninetyfive per cent of the total food grains production is estimated on the basis of yield rates obtained from these CCEs conducted on scientific basis spread over various States/UTs. Around more than one million CCEs are conducted covering 52 food crops and 16 non-food crops. The conduct of such a large number of CCEs had been in question since long. Accordingly, a high powered committee constituted by MoAFW has recommended for reducing the

sample sizes at different stages of sampling, which is highly being criticized and debated. In India, the Directorate of Economics and Statistics (DES) under Department of Agriculture & Cooperation (DAC), Ministry of Agriculture & Farmers Welfare (MoAFW), Government of India (GoI) releases estimates of area, yield and production of main food grain crops, oilseeds, sugarcane, fibers and important commercial and horticulture crops. These crops together account for nearly eightyseven per cent of the total output of agriculture. The estimates of crop production are obtained by multiplication of area estimates by corresponding yield estimates. Therefore, the estimates of area and yield rates assume immense importance in the entire gamut of agricultural statistics. The need for timely, reliable and comprehensive statistics on area, yield and production of crops assumes special significance in view of the vital role played by the agriculture sector in the Indian Economy. The primary responsibility for collection of statistics of land use and area under crops following prescribed procedures rests with the various State departments. The yield rates of principal crops are estimated through General Crop Estimation Survey (GCES) conducted by State agencies following scientific techniques of random sampling. Field Operations Division (FOD) of the National Sample Survey Office (NSSO) under the Ministry of Statistics and Programme Implementation (MoSPI), Government of India (GoI) has the overall responsibility for providing technical guidance to States/UTs in developing suitable survey techniques for obtaining reliable estimates, assistance in training of staff and exercising supervision. Under the Improvement of Crop Statistics (ICS) Scheme which was taken up during 1973-74 with the objective of locating, through the joint efforts of NSSO and State Governments, the deficiencies in the system of crop statistics by exercising technical supervision over the primary field work and suggesting remedial measures for improving the system. To achieve this, sample checks on area enumeration, and area aggregation are carried out in a sample of about ten thousand villages in each season and on conduct of around thirtyone thousand CCEs during an agricultural year. Data pertaining to CCEs for different crops, having smaller sample sizes, pertaining to good number of States under ICS scheme obtained from NSSO has been statistically analysed. Estimates of average yield pertaining to various food crops along with estimates of their percentage standard errors have been worked out. It has been observed that estimates of average yield for the two major crops viz. wheat and paddy have been obtained with suitable degree of precision, however, for minor crops like maize, barley, jowar, ragi etc., these were obtained with higher percentage standard errors. Sample sizes at the primary stage of sampling i.e. villages have been worked out for estimation of average yield of different crops for different levels of margin of errors. Data pertaining to area for different crops pertaining to different districts (20 survey numbers in a village) of some States under ICS scheme were obtained from NSSO and analysed. Estimates of total area under different crops have been obtained with estimates of very high percentage standard errors. However, these have also been worked out, had the sample size would have been increased from 20 survey numbers to 100 survey numbers. In that case, the percentage standard errors decreased significantly for number of crops. The main finding in this study is that on the basis of smaller sample sizes, the estimates of average yields of two major crops i.e. paddy and wheat may be estimated with suitable degree of precision in those States in which these crops are being grown as major crop. However, for other crops, these sample sizes may not be adequate for estimating the average yields of these crops with suitable degree of precision. For estimating these with permissible margin of errors, the sample sizes for these crops would have to be increased suitably.

PP12: Some inferential aspects of latin square designs in the presence of row and column neighbor effects
(Abstract Id: A1-1-007)

^aSobita Sapam, ^bBikas K. Sinha and ^cNripes K. Mandal

^aDepartment of Statistics,

Manipur University, Imphal, Manipur, India

^bRetired Faculty, Department of Statistics, Indian Statistical Institute, Kolkata, West Bengal, India

^cRetired Faculty, Department of Statistics, Calcutta University, Kolkata, West Bengal, India

ssobita1@gmail.com, bikassinha1946@gmail.com, mandalnk2001@yahoo.co.in

In a recent study, Sobita Sapam et al (2019) examined the nature of changes in the properties of the error functions and estimates of treatment contrasts in the presence of row and column neighbor effects. This was done with reference to LSDs of order 4. In this study we carry out the same for LSDs of orders 5 and 6. Briefly speaking, whereas the error functions are unaffected, treatment contrasts estimates are no longer unbiased in the presence of neighbor effects unless some conditions are satisfied. Presence of neighbor effects poses a 'threat' to the standard data analysis for an LSD.

PP13: A new method to interpret and compare sheep and goat data within multiple years

(Abstract Id: A1-1-017)

Saber Mohammad Maghsoodi and Hamid Reza Jalali
Agricultural office, statistical center of Iran, Tehran, Iran
sm.maghsoodi@gmail.com and hrjalali@gmail.com

Livestock sector statistics has a vital role in agriculture. In order to monitor this activity statistical center of Iran conducts livestock survey every 3 year mostly in Fall and Winter (Because significant contribution of sheep and goat herds are raised by nomads, so they are hardly accessible especially in spring and summer). we Always have problem with interpreting and comparing sheep and goat data in different years. Since the most Iranian sheep and goat breeds have seasonal variations in reproductive ability, so the number of these two livestock species are significantly varied in different months of the year. In other hand because of the resource constraints and some other problems, we couldn't implement livestock surveys in same month during the different years in Iran. To interpret and compare these surveys data over time it is necessary to understand the changes in the herd composition during the year especially along fall and winter; because in general, the breeding season of Iranian sheep and goat breeds starts in autumn and ends in winter. In order to assess changes, sheep and goat herds are categorized into 3 age groups based on their sex which are: number of livestock with the age of six month and less, 6 months to 12 months and more than one year and these groups also include the number of monthly birth. The survey had 3123 samples (every sample had 4 replacements in case of any problem that causes no response). Every sample interviewed face-to-face for the first month and interviewed by telephone in following months. The survey period was from October 2018 to February 2019. The results showed that during 6 months of survey, sheep and goat numbers tended to increase and in the last month of survey. The number of sheep and goat respectively increased by 27 and 24 percent more than the first month of the survey. So the total number of sheep and goat are maximized in the last month of the survey. Birth rate by monthly data showed that the February has the highest percent of births in both two species in Iran. In conclusion, because the number of female sheep and goat that their age are more than one year old had least coefficient of variation during the survey period (respectively 2% for sheep and 1% for goat) and it is the best indicator for comparing the number of sheep and goat across multiple years, so we suggested it is important that the age group for female sex included in questionnaires for all sheep and goat surveys.

PP14: Germplasm information system for chickpea

(Abstract Id: A1-1-048)

Devraj and Hemant Kumar
Division of Social Sciences, ICAR-IIPR, Kanpur, India
drmishra_1969@yahoo.co.in, rushtohemant@rediffmail.com

Chickpea is an important pulse crop in the semi-arid tropics particularly in the rainfed ecology of the

Indian subcontinent. Indian grows chickpea on about 10.56 m ha producing 11.23 m tonnes of grains, which represent 36% and 44% of the national pulse acreage and production. Indexing the genetic variability is a mega task for plant genetic resource workers to provide the end users with easily accessible as well as assessable information on materials they are working with. Ambiguous germplasm identification, difficulty in tracing different characteristics of germplasm data and lack of integration between genetic resources, characterization, evaluation and utilization data have been identified as major constraints in developing knowledge intensive crop improvement programmes. Germplasm Information System for Chickpea(GISC) addresses the data management need by producing a user-friendly interface that generates data entry forms, queries/reports and maintains a comprehensive database for statistical analysis and interpretations The system has been developed on three-tier Client–Server architecture using ASP.NET with C# and MySQL. Presently, the system contains information on 1097 evaluated for 22 important descriptors (14 qualitative traits and 8 quantitative traits) for each accession under Indian agro climatic conditions. Statistical analysis of the data was done on the variables to determine the mean, range, variance standard deviation, skewness and kurtosis. Total 4 main reports (Qualitative Report, Quantitative Report, Query-based Report, and Details report) have been designed to enable quick and accurate retrieval of data.

PP15: Linear regression diagnostics in cluster samples
(Abstract Id: A1-1-073)

Ashis Ranjan Udgata, Anil Rai, Prachi Misra Sahoo, and Tauqueer Ahmad
Agricultural Statistics, ICAR-IASRI, New Delhi, India
ashisu93@gmail.com, anil.rai@iacr.gov.in, prachi.iasri@gmail.com, tauqueer@iasri.res.in

Diagnosis of leverage and influence are an important part of model-builder's arsenal of tools. An observation is said to be influential if it has unusual x as well as unusual y co-ordinate. Detecting influential observations is important because these observations may have a disproportionate effect on the slope of the regression line as well as any predictions made using the regression line. These are the observations whose deletion would create noticeable change in the dataset. The statistics which are widely adopted for influence diagnostics in traditional linear regression modelling for nonsurvey data include DFBETAS, DFFITS, and Cook's Distance. Lee (1995) was probably the first person who described problem of outlier and its method of detection in survey sampling. The models and the sampling plans used for finite populations often entail stratification, clustering, and survey weights, which renders many of the standard diagnostics inappropriate. Li and Valliant (2015) adapted some influence diagnostics like DFBETAS, DFFITS and Cook's D for ordinary or weighted least squares in case of stratified, clustered survey data. The differences in the performance of ordinary least squares (OLS) and survey-weighted (SW) diagnostics were compared using two survey datasets namely NHANES and EU-SILC where the values of weights, response variables, and covariates vary substantially.

**PP16: Measuring the qualitative and contextual aspects of
farming for effective agricultural policies**
(Abstract Id: A1-1-043)

^aSiva Muthuprakash K M and ^bOm Damani
^aLivelihood, VikasAnvesh Foundation, Pune, India
^bComputer Science Engineering, Indian Institute of Technology Bombay, Mumbai, India
sivam@vikasanvesh.in, damani@cse.iitb.ac.in

Indicators play a central role in the development discourse and policy making. Importance and relevance of data collection and indicator estimation are ever increasing for a better planning and monitoring of public policies. While the current National Indicator Framework with 169 indicators

capture various descriptive aspects of 17 Sustainable Development Goals (SDGs), it is also essential to capture the qualitative and contextual aspects of the development scenario in different regions. For example, SDG targets like promotion of resilient agricultural practice and capacity building for climate change adaptation require to capture contextual and qualitative indicators of the region. This will enable the National Indicator Framework to act as a feedback system for designing appropriate policies, rather than observing SDGs as mere scoresheet and targets. A multi-tiered research tool based on a closed-ended questionnaire is designed to capture these contextual aspects of sustainable agriculture for a wide scale application. Initially, a questionnaire is developed to capture the multiple dimensions of each of the relevant qualitative parameters identified using an elaborate literature review, and vetted through stakeholder workshops. The questionnaire is refined on the basis of a hierarchical relationship matrix which appropriately captures the causalities, weightage, scores and ranks among the questions, choices and parameters of the system. Finally, the tool is validated through an iterative process which helped in building consensus on the design of indicator estimation from multiple-choice questions. Survey on farmers using this tool will aid the estimation of personal attributes of farmers and various socio-cultural phenomena which significantly affects the development process. The tool will also facilitate a feedback system that provides suggestive action plan to individual farmers for improving their farm management. Further, the proposed approach can be extended across all the SDGs that could reshape them into a more effective monitoring and planning aid for development policies.

PP17: Sampling methodology for estimation of private food grains stock at farm level aligned with input survey of agriculture Census in India
(Abstract Id: A2-2-036)

Tauqueer Ahmad, U.C. Sud, Ankur Biswas and Man Singh

Division of Sample Surveys, ICAR-Indian Agricultural Statistics Research Institute, New Delhi, India,

tauqueer.khan01@gmail.com, dr.ucsud@gmail.com, ankur.bckv@gmail.com,
mansinghjul59@gmail.com

In India, Food and Agriculture Organization of the United Nations (FAO) was implementing a project “Strengthening Agriculture Market Information System (AMIS) in India using Innovative Methods and Digital Technology” and supporting the efforts of the Ministry of Agriculture and Farmers Welfare, Govt. of India. This project identified the potential of improving the data coverage on ‘on-farm’ post-harvest management of food grains through Input Survey carried out in Agriculture Census. Therefore, a need was felt to conduct a pilot study on measurement of private food grains stock including estimation of on-farm post-harvest losses involving a pilot exercise under Input Survey of the ongoing programme of Agriculture Census 2015-16. In view of the above, a pilot study on private food grains stock estimation at farm level aligned with Input Survey of Agriculture Census in India funded by FAO-India was conducted by ICAR- IASRI. Under this study, a suitable questionnaire aligned with existing Input Survey of Agriculture Census has been developed covering different on-farm food grains stock and post-harvest management during storage at farm level. A suitable sampling methodology aligned with existing Input Survey for estimation of private food grain stock and post-harvest losses at farm level has been developed. An appropriate sampling design i.e. stratified two stage sampling design treating tehsils as strata, villages as first stage units (FSUs) and operational holders as second stage units (SSUs) being used in Input Survey was adopted. The ultimate sampling unit was an operational holder. Sample selection was done as per sampling design. Pilot survey was conducted in two states namely, Haryana and Madhya Pradesh. This being a feasibility study, one district was identified in each of the two states and two tehsils were identified in each of the two identified districts. The four crops under AMIS study i.e. wheat, paddy, maize and soybean along with pulses were covered under this pilot survey. The data was collected for all the three seasons. The seasons covered were Rabi 2015-16, Zaid 2015-16 and Kharif 2016-17. The data analysis was carried out using Statistical Analysis System (SAS) software available at ICAR-IASRI.

The SAS codes were written as per the proposed estimation procedures for suitable data analysis. The estimates of food grains stock, pre-harvest opening stock, production obtained, quantity sold, quantity stored, quantity disposed, percentage stock and percentage post-harvest loss at farm level were obtained along with its percentage Coefficient of Variation (%CV) and were found to be reasonably good for overall size classes. Therefore, it is expected that for overall holding size classes, the proposed methodology will provide farm level reliable estimates of food grains stock including post-harvest losses at district level. The study has established the feasibility of inclusion of developed questionnaire in the future Input Survey of Agriculture Census in India in order to estimate the food grains stock including post-harvest loss at farm operations which will bridge the gap on post-harvest information and private food grains stock in on-farm and off-farm domains of the supply chain.

PP18: Should we continue with the core module rather than focusing on cartography in the WCA? Lessons from agricultural censuses in Africa
(Abstract Id: A2-2-024)

^aAnakeu Etienne and ^bNgonthe Robert

^aNational Program for Sustainability and Strengthening Food Security (PNVRSA), Ministry of Agriculture and Rural Development (MINADER), Yaounde, Cameroon

^bInstitut Sous-régional de Statistique et d'Economie Appliquée (ISSEA), Yaounde, Cameroon
djoumessicadeau@yahoo.fr, rignonthe@yahoo.fr

Considering the fact that more than 54.2% of the population in Africa actually depends on agriculture to earn a living, considering that in many sub-Saharan countries, the rural sector contributes to the GDP for an average of 30-40%, and overall, considering that “food (and thus agriculture) is a common thread linking all the 17 Sustainable Development Goals”, the need of accurate, complete and reliable statistics appears to be a pending priority anywhere. These statistics would be useful either to governments for policy making, either to NGO and/or donors to support their advocacy or interventions. These uses of statistics easily justify the importance given to the World Programme for the Census of Agriculture (WCA) series, which are methodological guidelines and recommendations from the Food and Agriculture Organization of the United Nations (FAO), to be considered at the level of countries, when planning and executing agric censuses. Since 1930 when it started, the WCA have been regularly published on a decennial frequency, and each publication has always tried to strengthen past experience and take into consideration relevant limits. This paper proposes a contribution based on lessons learnt from agric census in some African countries over the period 2010-2015. Today, the WCA2020 edition to cover the period 2016-2025, have been launched worldwide, at the moment where 26 African countries over the 48 FAO members (54%) have not participated in the WCA2010. In addition, there are some 14 countries among these 26 outsiders (53%) which have not yet planed to participate in the WCA2020, while only 8 countries among the 22 ones which had their census (36%), have planned something for the 2016-2025. This critical situation opened the opportunity to question the reasons why the countries were not able (if they did not even try) or failed (if they tried) to organize censuses based on the modular approach in the past period, so as to prevent risks of failure in the coming decade. To meet this issue, we considered on the one hand a sample of countries which planned their census through a Technical Cooperation Project with FAO but did not execute it (Cameroon, Chad, Gabon*, Ghana, Madagascar* and Mali); and on the other hand we selected a sample of countries which achieved their censuses (Congo, Ivory Coast, Senegal and Togo). The methodology consisted of the review of official documentations, and we specially focused on the budgets and time of execution allowed to the main phases of the census, namely the cartography, the core module and the supplementary modules. All along, we assumed the hypothesis that the aim of the WCA2010 modular approach was to help countries minimize the cost of census-taking, while collecting a minimum set core data. Under this assumption, we simulated a utility function on censuses-taking; and an impartial cost-benefit analysis led us to the conclusion that a scenario where the core module was bypassed by the cartography, such a scenario would be optimal. Recommendation to countries could be to supplant the core module and invest more in cartography.

PP19: Integrated sampling methodology using field surveys, remote sensing and GIS for yield based crop insurance
(Abstract Id: A2-3-023)

^aTauqueer Ahmad, ^aPrachi Misra Sahoo, ^aAnkur Biswas and ^bAnil Rai

^aDivision of Sample Surveys, ICAR-Indian Agricultural Statistics Research Institute,
New Delhi, India

^bCentre for Agricultural Bioinformatics, ICAR-Indian Agricultural Statistics Research
Institute, New Delhi, India

tauqueer.khan01@gmail.com, prachi.iasri@gmail.com, ankur.bckv@gmail.com,
anilrai64@gmail.com

Agriculture is a very important natural resource and should be protected from every type of risk. In both developing and developed countries, the public crop insurance schemes have incurred losses without offering a perfect solution to the farmers. In the crop insurance sector, there is no robust and optimum result oriented survey methodology for crop yield estimation at Gram Panchayat level. Therefore, it is desirable to develop a robust operational sampling methodology for crop yield estimation using field survey based Crop Cutting Experiments (CCEs) and technologies like remote sensing technique, GIS and spatial interpolation techniques etc. for crop yield based crop insurance scheme. In view of the above, a study was undertaken by ICAR-IASRI, New Delhi during 2018-19 which was funded by Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Govt. of India. The main objective of the study was to develop an integrated sampling methodology for crop yield estimation in the context of crop insurance. This methodology was field tested for 3 crops namely Cotton, Wheat and Mustard in 3 states (one crop in each state) of the country. The study was conducted on Cotton crop in Buldhana district of Maharashtra State during Kharif 2018-19 and on Wheat and Mustard crops in Barabanki district of Uttar Pradesh State and in Murena district of Madhya Pradesh State respectively during Rabi 2018-19. In this study, the satellite data was used for stratification. Different indices namely NDVI, NDWI and SAVI were used to stratify crop area into homogeneous crop growth classes/strata. Ground truthing was carried out for all the conducted CCEs in the district and Latitude and Longitude of CCE plots were recorded using GPS. The district map with CCEs points was overlaid on the classified image of the district. Hence, the total number of CCEs identified within each stratum were used in obtaining the crop yield estimates with percentage coefficient of variation (%CV) for each stratum and pooling over strata. Further, within each stratum, only 30% CCEs were randomly selected and based on these 30% CCEs, a prediction surface was generated using spatial interpolation techniques such as Inverse Distance Weighting (IDW) etc. Using these prediction surfaces and classified image for the study crop, around 20 plots of study crops within each Gram Panchayat (consisting of around 4-5 villages) including actual CCE values, if falls within the Gram Panchayat (GP), were identified. Estimates of crop yield with %CV were obtained for all GPs in the district and were compared with estimates and %CV obtained using actual CCEs values for all GPs. It was observed that the estimates are close to actual CCE based estimates and %CVs are less than 10% at GP level and are less than the actual CCE based %CVs. Thus, this pilot suggests that number of crop cutting experiments can be reduced significantly, if satellite data is used along with CCE data. This study estimates the crop yield upto Gram Panchayat level with reliable degree of precision.

PP20: Technologies for data collection and data quality
(Abstract Id: A2-3-017)

Ahlam

Department of Statistics, Governorate Statistical, Amman, Jordan

At Jordan agriculture census implemented in 2017 by using latest technology of collecting, processing, and disseminating Data. Our experience have been built from population and house holding census 2015 which has been implemented by using technology in all stages (demarcation, listing, collecting), use tablet with online data checking ,processing and manipulating data) . Most important result of this success story is a capacity building of department of statistics staff whose have ability to developed systems of collecting data using capi for agriculture census 2017. In my paper i will show our experience s of using new technology include the following subjects • Processes of implement Jordan Agriculture census 2017. • Using GIS technology at the field. • Advantage and disadvantage of CAPI. • Comparison between CAPI and PAPI. • Quality Assurance of data and systems. • Opportunities and challenges • Recommendations. • Guidelines of using technology in collecting data The guidelines make several recommendations to NOS's in planning and designing their censuses with the use of handheld devices and/or the internet. The guidelines convey the following key messages to census managers: □ Decision making as to whether to use a particular technology or not should be organized as a process with the objectives of understanding the value of introducing the new approach, evaluating its cost-effectiveness and making the choice on the basis of the information gathered during this process; □ A step-by-step decision-making process should be applied for making a more deliberate decision on the feasibility of introducing a new approach, taking into consideration the potential risks of doing so and factors related to institutional, operational, social/cultural contexts of the country; □ o Given the fact that the adoption of electronic data collection requires a certain amount of capacity at the institutional and national levels, factors that are important for a successful adoption of new technology should be determined in the early stages of census planning; □ Total cost of ownership, referring to the estimate of the direct and indirect costs of developing and applying a particular product/system, should be calculated using three key components: software/hardware costs, operational costs, and personnel and training costs; □ Decision on the use of CAPI or CASI in censuses should be made with the involvement of all stakeholders/partners based on detailed analysis of the requirements, benefits, risks and the total cost of ownership; □ Early decision is necessary for the use of CAPI and/or CASI in order to have enough time to be able to build capacity, redesign census processes and undertake extensive testing for every component individually and in whole in an integrated way to ensure that the new approach will be implemented efficiently as planned; □ The adoption of CAPI or CASI in censuses requires strong project management expertise and capacity for planning, designing and implementing census operations;

**PP21: Agriculture Data Management, Access and Utilization
System for Malawi
(Abstract Id: A2-3-001)**

Emmanuel Jofilisi Mwanaleza
Department of Planning, Ministry of Agriculture, Irrigation and Water Development,
Lilongwe, Malawi
jofilisimwanaleza@yahoo.com

Malawi through the Ministry of Agriculture, Irrigation and Water Development (MoAIWD) is developing a comprehensive and efficient electronic agriculture data management, access and utilization platform as part of strengthening the national monitoring and evaluation system. The system fondly known as the National Agriculture Management Information System (NAMIS) is a single authoritative data source for the agriculture sector. The goal of the system is to facilitate development of the agricultural sector through timely provision of high quality data to all stakeholders at each level of the sector. The system aims at facilitating real time data collection and reporting at community, district and national levels through streamlined and 0computerized data

collection mechanisms and tools. To achieve its objectives, the system is being design to collect data in form of the following modules; Agriculture Statistics; Policies and Strategies; Resource Mapping; Human Resources; Estate Management Information; Agriculture Land Management Information; Public Agriculture Activity Monitoring; Non-State Activity Monitoring; Trade and Marketing; Water and Irrigation; Forestry; Fisheries; Farmer Organization and Social Accountability. In order to facilitate data management and utilization, the system will have customized dash-boards at all levels for decision making. These shall include: Community Score card; Geo-mapping; Gender and Inequalities; CountryStats; Food Balance Sheet; Budget Implementation Monitoring; Project Implementation Monitoring; National Development Goals Indicators, Resource Availability and Gap Analysis; Research and Evaluations Reports; Price, Production and Weather data. To ensure accountability of results for all partners in the agriculture sector, all players having a Memorandum of Understanding with the Government of Malawi will be reporting their project monitoring data through the system. The Computer Assisted Personal Interviewing (CAPI) will be an integral component of the system as such field staff will collect data using tablets. CAPI will be designed with automated consistency checks, appropriate validation rules and skips options as part of the quality control mechanism. For data generated routinely, automated calculation of the indicators will be programmed in the system. Data collected by the field staff will be submitted electronically to a server managed by data officers at sub-regional levels. At sub-regional levels, rights to the server will be assigned to these data officers. Data not collected using tablets such as administrative statistics will be entered manually at lower sub-regional levels. The data officer at these levels will be responsible for checking accuracy of data.

Quality control will be managed by sub-regional levels prior to submitting to the national level. At the national level, all data will be stored on a physical server and an off-site backup server. All data shall be quality checked and adjusted by the Statistics Unit. The unit will also ensure adequate liaison with the National Statistics Office (NSO) to guarantee adequacy of statistical methods used in computing the indicators in the system. The expected major benefit of the system is a strengthened national M&E system as a result of improved access to agricultural information through development and operationalization of an electronic data bank, dash-boards and website to meet various stakeholders' needs at all levels of the agricultural sector.

**PP22: Implementing area sampling frame on the estimation of the
harvested area of paddy: Indonesia's experience
(Abstract Id: A2-3-006)**

Ratna Rizki Amalia, Octavia Rizky Prasetyo and Kadir
Directorate of Food Crops, Horticulture, and Plantation Statistics, BPS-Statistics
Indonesia, Jakarta, Indonesia
ratna.amalia@bps.go.id, octavia.rizky@bps.go.id, kadirsst@bps.go.id

Since 1997, the production figure of paddy in Indonesia has been believed to suffer from overestimation. It has triggered a hot policy debate and controversy for many years about the rice policy in the country, especially when it comes to rice importation for price stabilization. In practice, the figure is obtained by simply multiplying the harvested area and productivity (yield per hectare). The former variable has been suspected as the main source of the bias (overestimation) as it was collected through a subjective measurement, mainly "eye-estimate" method, instead of objective measurement as in estimating the last variable through a crop cutting survey. To address this issue, in collaboration with the Agency for the Assesment and Application of Technology (BPPT), BPS-Statistics Indonesia has developed an objective measurement to estimate the harvested area of paddy in Indonesia by making use of an Area Sampling Frame (ASF) technique since 2015. Thanks to other government agencies assistance, the official figure of paddy production in Indonesia that was fully based on objective measurements was successfully released for the first time in 2018, ending the long

debate of the accuracy of the paddy statistics in Indonesia. This paper is aimed to share and explain Indonesia's experience in implementing ASF to estimate the harvested area of paddy focusing on two main issues, namely the development process of the method and its results that confirm the presence of a substantial upward bias in the harvested area figure obtained using the old method (a subjective measurement). The contribution of this paper is not only for the government but also for the researchers and agricultural experts. For the government, especially Statistics Indonesia, this paper provides a real picture of the process of implementing improved rice statistical data that is being developed by BPS-Statistics Indonesia as an effort to obtain accurate rice data. For researchers and agricultural experts, this paper is to enrich the knowledge and discussion about the methodology of producing the paddy statistics, especially in Indonesia.

PP23: Teaching CAPI from the cloud: Lessons learned from piloting an online training course on computer-assisted personal interviewing (CAPI)
(Abstract Id: A2-3-013)

Lakshman Nagraj Rao and Jude David Roque
Statistics and Data Innovation Unit- Economic Research and Regional Cooperation
Department, Asian Development Bank, Mandaluyong, Philippines
nagrajrao@adb.org, jroque1.consultant@adb.org

Data collection modes matter for agricultural surveys, and not to mention just about any national survey or census. Ultimately, they underpin the timeliness and quality of the data. As such, any movement to streamline and upgrade this process should be welcomed by national statistical systems. This is relevant because most data collection processes in developing countries still rely upon traditional pen-and-paper interviewing (PAPI) techniques that are prone to data issues with implications for survey or census quality. As such, the digital age has brought forth computer-assisted personal interviewing (CAPI) that allows enumerators to use mobile devices instead of paper questionnaires to record responses. The literature and recent evidence posit that CAPI addresses PAPI's limitations as far as data quality, timeliness, and cost. Meanwhile, widely used CAPI software programs like CSPro and Survey Solutions are free to use. This suggests that the resources are all there for national statistical systems to transition and adopt CAPI. The only issue really is to figure out a way to disseminate such knowledge and technology efficiently. In line with this, over a period of eight weeks, the Asian Development Bank (ADB) in partnership with the Food and Agricultural Organization of the United Nations (FAO) conducted two free online training courses on CAPI. Both courses look at CAPI questionnaire design, data collection, and data management, focusing on two different software packages: CSPro and Survey Solutions. The pilot course was mainly targeted towards national statistics offices, other relevant government agencies, the academe, and researchers. Each course consisted of eight modules that were released every week. Consequently, this study aims to shed light on the merits of the online training course channel or methodology to disseminate CAPI knowledge based on the lessons learned running the pilot online CAPI courses. Particularly, the study also looks at the factors that underpin student motivation and performance. This has implications for online course design and implementation. In terms of statistical policy, this has implications for potentially streamlining the dissemination of CAPI through online training.

PP24: Stock assessment in data poor environment: a case study of marine fishery in Andaman-Nicobar islands
(Abstract Id: A2-3-033)

Eldho Varghese, Sathianandan T. V, Jayasankar, J, Somy Kuriakose, Mini K.G. and
Grinson George
Fishery Resources Assessment Division, ICAR-CMFRI, Kochi, India

eldhoiasri@gmail.com, tvsedpl@gmail.com, jjsankar@gmail.com,
somycmfri@gmail.com, mini.anish02@gmail.com, grinsongeorge@gmail.com

Under-utilized fishery is a rarity among heavily fished global fish stocks. Andaman and Nicobar Islands with high unused deep sea resource potential and a comparatively small coastal fishery is an interesting case to apply the stock assessment tools to really look into the status of the marine fishery. Catch estimates generated by the local administration is the only available data source. A major drawback in the data collection is that no measure of fishing effort is available. A Monte-Carlo approach for estimating fisheries reference points as well as relative stock size and exploitation from catch data and a proxy for biomass using species resilience has been described. Priors for resilience were worked out using the species resilience taken from Fishbase (www.fishbase.org). The procedure adopted for estimating the Maximum Sustainable Yield (MSY) of 10 species/species groups using data collected from Andaman-Nicobar Islands coastline during 1993-2016, where Catch Per Unit Effort (CPUE)/ biomass was not available. It has been seen that the exploitation rate is low for most of the resources.

PP25: Mobile based decision support system for crop selection

(Abstract Id: A3-5-033)

^aRohit Singh, ^aShashi Dahiya, ^bRajni Jain, ^aAnshu Bharadwaj, ^aMukesh Kumar and
^cRamasubramanian V

^aComputer Application, ICAR-IASRI, New Delhi, India

^bComputer Application, ICAR-NIAP, New Delhi, India

^cAg. Statistics, ICAR-IASRI, New Delhi, India

rohitsingh12108@gmail.com, shashi.dahiya@icar.gov.in, rajni.jain1@icar.gov.in,
anshu.bhardwaj@icar.gov.in, mukesh@icar.gov.in, R.Subramaniam@icar.gov.in

Agriculture is one of the important contributors to the Indian economy. Getting the high crop returns in agriculture depends on several factors like soil condition, climatic condition, rainfall, selection of suitable and optimum amount of the input materials etc. All of these factors contribute to good output. The farmers are always in dilemma about which crop to be grown and what inputs need to be given in their specific area. They also don't know what would be the possible return and the maximum profit from that crop. There are a number of mobile apps developed for various agricultural issues, still, there is a need for an application that can guide a farmer to make decision about which is the most profitable crop for him. The mobile based DSS for Crop Selection provides decisions to the Indian farmers based on his specific region, farm size and specific season based on the economic criteria. Presently it provides the crop selection decision to the Haryana state farmers for selecting their crop for getting maximum output. It also advises the farmers about what inputs he should apply and what will be the approximate output and profitability from that crop. The Decision Support System for Crop Selection has been developed on Android Studio 2.3.x. The minimum requirement for the app is a device running on API 15: Android 4.0.3 (IceCreamSandwich). Programming language used to develop DSS for crop selection is Java and Xml. Tools used to develop the app are SQLite, Android Studio IDE, Android Device Monitor, and Mozilla Firefox. The app provides an easy interface to the user which help the farmer to make the decision about their crop, it also provides the information about the right quantity of inputs to be applied to the crop. The DSS also provides the information about the output of the main product and returns from the by-product and main product.

PP26: Deep learning for plant disease identification

(Abstract Id: A3-5-018)

^aSapna Nigam, ^bRajni Jain, ^aSudeep Marwaha, ^aAlka Arora and ^cVaibhav Kumar Singh

^aComputer Application, ICAR-IASRI, New Delhi, India

^bComputer Application, ICAR-NIAP, New Delhi, India

^cPlant Pathology, ICAR-IARI, New Delhi, India

sapna.nigam1010@gmail.com, rajni.jain@icar.gov.in, sudeep.marwaha@icar.gov.in,
alka.arora@icar.gov.in, dr.singhvaibhav@gmail.com

In a present scenario where India must produce more food with fewer resources for the increasing population, Artificial Intelligence holds the promise of driving a revolution in Indian agriculture. In recent years, the rapid adoption of Artificial Intelligence techniques in agriculture domain has seen an impressive increase, especially for in-field farming techniques. Plant diseases are a major threat to food security at the global scale and can have disastrous consequences for farmers whose livelihoods depend on crops. This study employs a promising deep learning technique for identifying disease in the wheat crop in India. In wheat, rusts and powdery mildew are the most devastating fungal diseases and cause epidemics too. Wheat rusts and powdery mildew spread rapidly and reduce wheat yield and quality. It can cause grain yield losses higher than 50 percent under severe epidemics. Identifying a disease correctly when it first appears is a crucial step for efficient disease management. In this direction, neural networks and other machine learning techniques provide useful information for disease diagnosis to farmers to some extent. Global smartphone penetration and recent advances in computer vision have paved the way for using deep learning for image-based plant disease detection in recent years. In particular, a deep learning technique, convolutional neural networks has achieved an impressive result in the field of image-based plant disease classification in China, USA, and other advanced countries. However, such attempts have been negligible for Indian farmers. This study presents preliminary deep learning based model to identify disease infected leaves of wheat crop. In order to develop accurate image classifiers for the purposes of plant disease diagnosis, a verified dataset of images of diseased and healthy plants is used. Images of infected leaves of wheat crop from the field are captured. Different pre-processing techniques and data augmentation techniques are applied to the image dataset for the overall efficient performance of deep learning model. The experimental results based on developed deep learning models show more than 90 percent accuracy. Deep learning based models for plant disease recognition may further be used for issuing a faster mobile- based advisory to farmers after receiving a picture of the disease-infected plants from farmers on an individual basis.

PP27: Maize disease classification using deep CNN model (Abstract Id: A3-5-032)

^aSudeep Marwaha, ^aMd. Ashraful Haque, ^aChandan Kumar Deb, ^aAlka Arora, ^aMukesh Kumar and ^bKarambir Singh Hooda

^aComputer Application, ICAR-IASRI, New Delhi, India

^bPlant Pathology, ICAR-IIMR, Ludhiana, India

Sudeep.Marwaha@icar.gov.in, ashrafulhaque664@gmail.com,
chandan.iasri@gmail.com, Alka.Arora@icar.gov.in, mukesh.kumar@icar.gov.in,
hoodaks@gmail.com

In the present scenario, the Deep Learning concept is being used apparently in every aspect of life. This tool is a great means of Artificial Intelligence for better knowing the unknowns facts of the nature. Currently, Deep Learning is also being applied in many aspects of the agriculture sector. The Disease detection and classification task is one of the major areas of the utilization of deep learning in the field of agriculture. In this research work, we have taken three diseases of maize crop for classification purpose from the PlantVillage dataset, a publicly available dataset. This dataset contains images of Common rust, Gray Leaf Spot, Northern Leaf Blight as well as healthy leaf. We have developed a 13 layer deep CNN model in which 6 layers of Convolution with activation function of

‘RELU’, 6 layer of MaxPooling and 1 Dense layer activation with ‘RELU’ and classification with ‘SOFTMAX’ has been used. We have used ‘adam’ for optimization, ‘categorical entropy’ for loss function. For this model development, 1376 images has been used for training and 153 images for testing. While training we have used batch size of 16 with 100 epochs. The whole experiment is conducted using keras packages backend with tensorflow in GPU environment. The GPU environment contains NVIDIA Quadro P400 graphics card of 2GB. The developed model takes 8 hrs of training time and gives 99.92% training accuracy and 90.80% testing accuracy using the mentioned dataset. The developed model can be embedded into mobile app for automatic disease detection that will be helpful for a large no of farmers.

PP28: Spike identification and counting in wheat plant by using convolutional encoder-decoder network - A deep learning approach
(Abstract Id: A3-5-030)

^aTanuj Misra, ^aAlka Arora, ^aSudeep Marwaha, ^bViswanathan Chinnusamy, ^cAtmakuri Ramakrishna Rao, ^dMrinmoy Ray, ^bSudhir Kumar, ^bDhandapani Raju and ^eRajni Jain

^aComputer Applications, ICAR-IASRI, New Delhi, India

^bDivision of Plant Physiology, ICAR-IARI, New Delhi, India

^cCentre for Agricultural Bio-Informatics , ICAR-IARI, New Delhi, India

^dForecasting and Agricultural Systems Modeling, ICAR-IASRI, New Delhi, India

^eICAR-NIAP, New Delhi, India

tanujmisra102@gmail.com, alka.arora@icar.gov.in, sudeep.marwaha@icar.gov.in,
viswa.chinnusamy@gmail.com, ar.rao@icar.gov.in, mrinmoy.roy@icar.gov.in,
sudhir.kumar@icar.gov.in, Dhandapani.raju@icar.gov.in, rajni.jain@icar.gov.in

Wheat is one of the three major cereal crops and cultivated since the beginning of agriculture to support approximately 30% of the world population. Urbanization and rising incomes are driving a rapid rise in the global wheat consumption. It is predicted that, by 2050 consumers will require 60 percent more wheat than today (<https://wheat.org/wheat-in-the-world/>). Therefore significantly improved varieties are needed to deal with rapidly growing human population scenarios. High throughput and non-destructive plant phenotyping is emerging as major approach for phenotyping germplasm and breeding populations for identification of superior donors, lines and QTLs. Detection and counting of spikes, the grain bearing organs of wheat, is critical for phenomics of large set of germplasm and breeding lines in controlled and field conditions and is also an important measure to determine the yield. Digital image analysis and machine learning techniques play an important role in non-destructive plant phenotyping analysis. In this study, an approach based on computer vision, particularly object detection, to recognize and count number of spikes of the wheat plant from the digital images has been proposed. Visual side images of 200 wheat plants were captured at 00, 1200 and 2400 angles using automated imaging system at Nanaji Deshmukh Plant Phenomics Centre, ICAR-IARI, New Delhi, India for the present study. For spike identification, deep convolutional encoder-decoder network architecture has been used which consists of 3 encoder blocks and corresponding hierarchy of 3 decoder blocks, whereas for counting number of spikes per plant, flood-fill image analysis technique has been used on the output image of the encoder-decoder model. For spike identification, precision, accuracy and robustness (F1 score) of the proposed approach were found as 99.95, 99.96 and 99.96% respectively, while for spike counting the precision, accuracy and robustness were 99, 94 and 92% respectively. Although the proposed encoder-decoder model for detecting/identifying spikes achieved 99.96% accuracy but counting accuracy is comparatively less (94%). This is because of overlapping of spikes and invisibility of some spikes which are hidden behind other plant structures. Online software for identification and counting of wheat spikes has also been developed by using the proposed approach. Client Side Interface Layer (CSIL) of the developed software has been implemented using Hyper Text Markup language (HTML), Cascading Style Sheet

(CSS) and JavaScript technology. Server Side Application Layer (SSAL) has been built using Flask web-development tool for taking the input from users and deep learning module built with Tensorflow, Keras framework and Numpy, Scipy, Matplotlib, OpenCV etc. libraries of python for detection of spikes and ImageJ module has been used to count the objects (or, spikes) on the output image of the deep learning model.

**PP29: OSIS: Oilseeds statistical information system for visualization and analytics
using google spread sheets
(Abstract Id: A3-15-002)**

Sarada Chunduri, Umesh Kashyap, K Alivelu, K S Varaprasad and A Vishnuvardhan
Reddy

ICAR-Indian Institute Of Oilseeds Research, Hyderabad, India
c.sarada@icar.gov.in, umeshkashyap285@gmail.com, k.alivelu@icar.gov.in,
prasadksv@gmail.com, c.sarada@icar.gov.in

Nine annual oilseeds crops viz., groundnut, soybean, rapeseed and mustard, sesamum, castor, sunflower, safflower, linseed and niger are grown across India. ICAR-Indian Institute of Oilseeds Research, Hyderabad, the premier oilseeds research institute is involved in knowledge management of oilseed crops. Enormous data on oilseeds situation such as area, production, productivity, exports and imports etc. available in public domain needs to be extracted for getting update knowledge on oilseeds situation in the country. But extraction and deciphering this data is a cumbersome and time taking process. If this enormous data is put in an interactive and searchable mode, it would be easier for end users to go through the data in a short period for developing a knowledge base on oilseeds situation. Therefore, an interactive Oilseeds Statistical Information System (OSIS) was developed using time series data on oilseed crops. Fifty years (1966-67 to 2016-17) data on area, production and yield of nine oilseeds crops at national/State/district level was downloaded from <https://eands.dacnet.nic.in/>. The data then collated and formatted into flat files for making it amenable to develop Oilseeds Statistical Information System (OSIS). OSIS was developed in google spread sheets using google API query language, google scripts, and statistical and logical functions. It is an interactive dynamic search mode system which can be shared online. Using OSIS one can search national/State/district level information on area, production and yield of nine oilseed crops in various combinations for e.g., if user is interested to compare production between two states over years. He/she can dynamically query by selecting crop, state and years from drop down menus. The search output can be simultaneously visualized in graphical form along with descriptive statistics. The growth rate and coefficient of variation (CV) would also be displayed along with descriptive statics and graphs. OSIS is amenable for updating and modification as and when required. It is a user friendly information system for researchers, students, policy makers, oilseeds growers, department of agriculture and allied sectors for acquiring information on oilseeds at national/State/district level in tabular and graphical forms along with statistical analytics.

**PP30: Did five-year plans or farm policies have differential on rice, wheat and maize
efficiency and productivity?
(Abstract Id: A4-6-023)**

Saleem Shaik,
Center of Farm Policy and Trade Studies, North Dakota State University, Fargo, USA
Saleem.Shaik@ndsu.edu

Technology led development in agriculture has made India self-sufficient in food grains and a leading

producer of other agricultural commodities in the world. The green revolution in foodgrain crops, yellow revolution in oilseeds, white revolution in milk production, blue revolution in fish production and golden revolution in horticulture bear an ample testimony to the contributions of agriculture research and development efforts to efficiency and productivity or total factor productivity (TFP) growth in the country. Efficiency and productivity as a core of economic growth has been the subject of substantial research for more than half of century across the world. Many studies, conducted over that period, significantly enhanced the knowledge about the sources of efficiency or productivity growth. The farm policies introduced as part of the five-year plans are expected to have positive effect on increasing farm income and improve efficiency and productivity. However, the long-term policy debate of introducing the farm policies as five-year plans are the differential impacts on rice, wheat and maize. This research estimates efficiency and productivity using alternative approaches (i) Stochastic frontier analysis (SFA) approach; and (ii) Mathematical data envelopment analysis (DEA) approach. The technology that transforms inputs into outputs can be represented by graph set. The graph set satisfying constant returns to scale is defined as the collection of all input vectors that yield output vector. In contrast with earlier productivity measures, this study uses the cost of cultivation data on per hectare basis in the estimation. Input-output data from the reports of a comprehensive scheme Cost of Cultivation of Principal Crops in India, Ministry of Agriculture, Government of India were compiled, and used for measurement and analysis of Indian productivity. Under cost of cultivation scheme (CCS), data from the selected sample were collected by cost-accounting method every crop year since 1970 for all major crops in India. The summary of key variables of this data such as all inputs and output will be published every year with 3-4 years lag. The time series data on quantities and values of inputs were collected from all available reports of CCS for the period 2000 to 2014 at the plot level. Quantity data was available for output, however the input cost available in rupees per hectare are converted into implicit quantity index using implicit input price deflators. Policy variables are collected and construct from various sources including FAO, World Bank, Central Statistical Office, Delhi and State Directorate of Economics and Statistics. Specifically, efficiency and productivity changes by five-year plans will allow us to evaluate the changes due to revised green revolution, capital building, free market economy and export enhancement programs. Second, the differential impact on rice, wheat and maize efficiency and productivity will be examined.

**PP31: Effects of hydro-agricultural dams on agricultural income of farmers: evidence
from Sologo, Solomougou and Tchalongi dams in Ivory Coast
(Abstract Id: A4-6-060)**

Lao Kenao

Ministry of Agriculture of Togo, Direction of Agricultural Statistics, Informatics and
Documentation (DSID), Lome, Togo,
kenaolao@yahoo.fr

This study explored the analysis of the household poverty situation using household per capita consumption expenditure. Descriptive statistics and multiple linear regression estimation were used to describe, identify factors that have significant effects on farm income per hectare of producers in dam areas. The results show that the incidence of poverty is high and estimated at 73.7%. The total number of "sold" livestock, the area under 0.75 ha, the large area under cultivation (between 1.5 and 8 ha) and the size of the household have a significant effect on income per hectare. In addition, being a member of an organization, to be installed in the Sologo and Tchalongi dam have a significant effect on the farm income per hectare of the producer. Therefore, improving the quality, expansion and distribution of dams' water is likely to improve regular access to water for producers while improving farm income per hectare producers.

**PP32: Impact assessment of tractorization on farm productivity
in SAT India**

(Abstract Id: A5-7-031)

Ravindra Singh Shekhawat, K N Singh, Achal Lama and Bishal Gurung

F&ASM, ICAR-IASRI, New Delhi, India

ravindra.shekhawat@icar.gov.in, knsingh@iasri.res.in, achal.lama@icar.gov.in,
vsalrayan@gmail.com

Tractor is one of the most versatile farm machines that supplies traction power to several farm implements. Over the last few decades, tractor becomes an important component for agriculture in arid and semi-arid area. In Semi-Arid Tropic (SAT) India, tractors are widely used for farming operation, rural transportation and for various non-farm activities in urban areas, as well. Previous studies were carried out in India at the time when agricultural labourers were surplus with very high ratio of labour to land ratio and very high proportionate of rural population depended on agriculture for their employment and livelihood. In 1970s and early 1980s, many studies reported that rural economy of India would not even ready for introduction of tractor, in near future due to smallholding and rampant unemployment in the rural India (Binswanger, 1978, 1986, and Agarwal, 1981). However, after liberalization of Indian economy, i.e., after mid of 1990s, the tractors use in India has spurred up dramatically, particularly in SAT India. Therefore, time has come to assess the impact of rapid adoption of tractor on farm productivity in SAT India. There is virtually no recent study on impact of tractorization on farm productivity specially in dry region and in SAT region of India. In this paper, we have tried to assess impact of tractor on farm productivity in semi-arid India. We have used household level data from Village Dynamics of South Asia (VDSA) published by ICRISAT. To assess the impact of tractor on productivity, we used panel modeling. The study findings would be useful for applied policy analyses and designing evidence based farm mechanization policy, and including policies in SAT region and in dry region of India.

PP33: Seed replacement in pulses and its impact on productivity in India

(Abstract Id: A4-6-033)

^aShivaswamy G.P, ^bAvinash Kishore, ^bP K Joshi, ^bKuhu Joshi and ^aK N Singh

^aForecasting and Agricultural Systems Modeling, ICAR-IASRI, New Delhi, India

^bIFPRI, International Food Policy Research Institute, South Asia Office, New Delhi,
New Delhi, India

Shivaswamy.GP@icar.gov.in, avinash.kishore@gmail.com p.joshi@cgiar.org,
Kuhu.Joshi@cgiar.org kn.singh@icar.gov.in

Quality seed is the embodiment of technological change in agriculture and forms the basis for enhancing agricultural productivity. In India, while pulse productivity is on the rise, its growth has been much slower when compared to cereals, and shrinking availability of pulses has become a concern for nutrition as well as inflation. We evaluate the drivers of seed replacement and its ex-post impact on yields of chickpea and pigeonpea pulses in India. We use data on 1764 chickpea and 944 pigeonpea farmers from the nationally representative Situation Assessment Survey of Agricultural Households conducted in 2013. The percentage share of farmers replacing seeds in chickpea was highest in Gujarat (86%) and Andhra Pradesh (75%). Whereas in the states of Chhattisgarh (32%) and Madhya Pradesh (41%), a higher proportion of farmers still use their own farm-saved seeds. In case of pigeonpea, the largest share of farmers replace seeds in Andhra Pradesh (83.54%) followed by Telangana (67.39%). It is least in Madhya Pradesh (37.85%) and Karnataka (38.78%). Using a probit

regression, we find that access to irrigation and credit are the important determinants of seed replacement in chickpea. Importantly, household factors such as age and gender, and socio-cultural factors such as caste do not play a role in the decision to replace seeds. If farmer replaces seeds in other crops, then he will also replace in chickpea and pigeonpea. This implies that there is no bias in seed replacement among different crops cultivated by the farmer. Chickpea farmers in districts under the National Food Security Mission on pulses (NFSM-pulses) are more likely to be replacing seeds suggesting the importance of such policy interventions. Access to irrigation alone is the key driver in pigeonpea. Further, using coarsened exact matching estimation, we find that seed replacement increases chickpea yields by 117.36 kg per hectare, but there was no such positive impact in case of pigeonpea. However, NFSM- pulses coverage had no significant influence on seed replacement in pigeonpea.

PP34: Use of econometric approaches for impact evaluation of weed management technologies in central India

(Abstract Id: A4-6-051)

Yogita Gharde and P K Singh

Extension and Statistics, ICAR-Directorate of Weed Research, Jabalpur, India

Yogita.Gharde@icar.gov.in, drsinghpk@gmail.com

Weed research provided many solutions to weed management problems for farmers. Many technologies have been evolved for weed management such as cultural, mechanical, chemical, biological etc. Farmers use any one or mixture of these technologies as weed management options. Over the last four decades, most of the solutions to weed problems have been based on herbicide technology. However, extensive herbicide use may have negative impact on environment, soil, water and on non-target organisms. Nowadays, attention is now increasing to aid the effectiveness of the technology as a means to quantify its impact on productivity of farm as well as livelihood security of the farmers. In view of the above, a study was conducted to assess the impact of weed management technologies being disseminated by ICAR-Directorate of Weed Research, Jabalpur in the central India during 2014-17. For the purpose, filled pre-tested questionnaires were collected from farmers of central part of India constituting a total sample of 92 respondents. Various econometric approaches such as Analytical Hierarchy Process, Partial budgeting technique and Likert scale were employed for interpretation of the data. Results indicated that before and after the adoption of weed management technologies, yield and total cost of production in rice and wheat crops showed significant differences ($p < 0.01$) in the central zone. It further verified that weed severity decreased to a significant extent after adoption of these technologies which uses Likert scale. Results from partial budgeting showed that adoption of weed management technology yielded an average increase in yield of about 6.2 and 5.4 q/acre in rice and wheat crop, respectively, which ultimately resulted the substantial net profit of Rs. 9605 and 9691 per acre in rice and wheat, respectively in the central zone. Analytical Hierarchy Process (AHP) found out the major agencies which play important role in disseminating the weed management technologies to the farmers. In the zone, demonstrations on weed management conducted by centre play important role in disseminating the information to the farmers. On the other hand, other extension functionaries/State line departments/NGOs were moderately involved in providing weed related information in zone.

PP35: Credit to agriculture by Scheduled Commercial Banks (SCBs) in India-A micro level overview

(Abstract Id: A4-6-044)

Harish Kumar H.V, Shivaswamy G.P, Anuja A.R, Achal Lama, K.N. Singh and Rajesh T

Division of Forecasting and Agricultural Systems Modeling, ICAR-IASRI, New Delhi,
India

Harishkumar.HV@icar.gov.in, shiva644@gmail.com, Anuja.AR@icar.gov.in,
chllm6@gmail.com, kn.Singh@icar.gov.in, rajesh.5073@gmail.com

Since independence, agricultural credit in India has undergone substantial transition pertaining to cost of credit, extent, source and mode of supply owing to various policy reforms in the credit system. Pervading effects of these interventions helped the farmers of the country to reap the benefits of cheaper credit from institutional sources by gradually reducing their dependence on costlier non-institutional sources. But still issues like persistence of non-institutional lenders, mounting Non Performing Assets, inadequate credit delivery and intensifying regional disparity needs to be addressed at grassroot level. Lack of grassroot level data on credit to agriculture by co-operatives limiting the policy makers to check adequacy. In 2017-18, SCBs (87.26 %) are the major institutional/formal credit source to agriculture followed by co-operatives (12.74 %). Information on status of credit supply at grassroot level helps in checking the regional imbalances, hence the study aimed to cluster the districts based on outstanding credit of SCBs to agriculture using the districtwise data for the latest periods (2015-16, 2016-17 & 2017-18). To avoid the misclassification that could occur by using a single year data, triennium average of district wise outstanding credit is arrived which nullifies the problem of extremities in weather which would have occurred in a single year. Regionwise triennium averages revealed that more than half of the agricultural credit by SCBs is concentrated in Southern (38%) and Northern regions (21%) together; particularly states like Tamil nadu, Uttar pradesh, Andhra Pradesh, Karnataka and Maharashtra. Districtwise triennium average of 651 districts is subjected to cluster analysis and based on euclidean distance the districts are grouped into three clusters. First cluster consists of 50 districts representing scenario of high concentration (₹4,645.57-₹11,751.23 crores) and they formed 31.31 per cent of countries total advances to agriculture by SCBs. Districts like Guntur, West Godavari, Hyderabad, East Godavari, Mumbai, Pune, Krishna, Bangalore Urban, Prakasam and Belgaum topped the list covering 10 per cent of SCBs advances to agriculture in the country. Indirect finance formed a significant share in the districts with metropolitan cities like Hyderabad (30.14 %), Mumbai (45.03 %), Pune (14.18 %) and Bangalore Urban (28.44 %) which is induced by favourable investments in the agro-based industries. High irrigation coverage in the districts like West Godavari (90.05 %), East Godavari (70.32 %), Guntur (58.85 %) and Krishna (51.32 %) favoured significant direct finances. Second cluster consists of 181 districts representing scenario of medium concentration (₹1,623.38-₹4,518.45 crores) consisting majorly Southern and Northern districts covering 47 per cent of SCBs advances to agriculture. Third cluster consists of 420 districts representing scenario of low concentration (₹0.53-₹1,590.35 crores) consisting majorly Eastern and North-Eastern districts covering just 21.69 per cent of SCBs advances to agriculture. The analysis provides distinct groups of districts which helps in framing policies accordingly to minimize the regional imbalances and achieve the goal of sufficient and cheaper institutional credit.

PP36: Research and development outlay in Indian Agriculture: An overview
(Abstract Id: A4-6-045)

Rajesh T., Shivaswamy G. P., Anuja A. R., R. S. Shekhawat, K. N. Singh and
Harishkumar H. V

Division of Forecasting and Agricultural Systems Modelling, ICAR- IASRI, New Delhi,
India

Rajesh.T@icar.gov.in, Shivaswamy.GP@icar.gov.in, Anuja.AR@icar.gov.in,
Ravindra.Shekhawat@icar.gov.in, kn.Singh@icar.gov.in, Harishkumar.HV@icar.gov.in

Globally, it is a well-articulated fact that agricultural growth is driven by technology, investments, enabling institutions and favourable policies. India's agricultural GDP witnessed phenomenal growth since Green Revolution following significant investments in public rural goods especially agricultural research, infrastructure and irrigation. During 1970s and 1980s, agricultural GDP growth attained new peaks; however, this impressive growth performance could not be sustained for long and showed a marked slowdown during late nineties till early years of the last decade. It is attributed to degradation of the land resources, declining infrastructure and research investments, rise in energy prices, inefficient markets etc.

Many findings reiterated that the desirable way for increasing farm profitability is by achieving agricultural growth induced by sufficient investments in the sector in the form of infrastructure and R&D. Achieving these goals not only requires a significant increase in agricultural spending but also requires setting right priorities and improving efficiency in spending. Hence we examined the temporal variations and spatial differences in public expenditure on agricultural research and development in the context of India. Results revealed that Tamil Nadu (₹3057 crores), Uttar Pradesh (₹2020 crores) and Andhra Pradesh (₹1808 crores) as top three states with higher public agricultural expenditure in India. In regard to agricultural R&D expenditure, Tamil Nadu (₹1203 crores), Uttar Pradesh (₹513 crores) and Uttarakhand (₹189 crores) topped the list. About 53 percent of total agricultural R&D expenditure was concentrated in Tamil Nadu state alone, followed by Uttar Pradesh (23 %). At all India level, agricultural R&D expenditure accounts for about 13 percent of total agricultural public expenditure. Region-wise analysis indicated that the Southern states received around 40 percent of total public agricultural expenditure followed by Northern states (26 %) and Western states (16 %). In case of agricultural R&D expenditure, results showed that both Southern and Northern states together accounted for more than 90 percent of total public agricultural R&D expenditure in India. Sector wise analysis of public agricultural expenditure revealed that Irrigation (36 %) followed by agricultural inputs and services (21 %), Infrastructure (17 %) and Research and Development (13 %) received major attention. Share of agricultural R&D expenditure in total public agricultural expenditure in Northern, Southern, Eastern, Western, Central and North-Eastern states of India were found to be 20.20 percent, 20.90 percent, 5.60 percent, 3.50 percent, 1.70 percent and 4.60 percent respectively. Trend analysis identified a negative growth in states like Tamil Nadu (-11.87 %) and Uttar Pradesh (-21.57 %) which enjoyed higher share in public agricultural expenditure. Whereas states like Gujarat (17.14 %), Meghalaya (17.32 %) and Kerala (13.21 %) had positive growth rate. Agricultural R&D expenditures are more concentrated in Northern and Southern states of the country and these disparities need to be redressed in order to achieve regional balance and holistic development.

**PP37: The Role of Formal and Informal Rural Credit on Crop Yield Distributions and
Downside Risk
(Abstract Id: A9-14-002)**

Sumedha Shukla and Gaurav Arora

Department of Economics, Indraprastha Institute of Information Technology, New
Delhi, India

sumedhas@iiitd.ac.in, gaurav@iiitd.ac.in

The coexistence of institutional and informal credit sources is a key feature of rural credit markets in developing countries. Since the green revolution, the Indian government has given priority to increase the formal credit in agriculture. This can be justified as credit might work as a mitigation device against systemic risks in crop yields, which often lead to wide-scale crop failure. However, formal credit institutions compete with the informal credit market, which has low transaction costs: minimal formalities, fast disbursement, geographical and personal proximity. Though agricultural risk might

be categorized into: production risk (i.e., impacts yields) and price risk (i.e., impacts farm income), we will focus on the production risk in agriculture and the role of credit in mitigating it. There are three major policy instruments (apart from subsidies) for managing production risks in India: credit, insurance (PMFBY & WBCIS) and direct benefit transfers (PM-KISAN). We will provide a systematic understanding of the role of credit in determining farm yields in order to assess its risk mitigation properties, especially for the left tail in the yield distribution. The econometric estimation with propensity score matching will be guided by a 2-period agricultural household decision-making model to evaluate the impact of credit on farm-level production, which may be otherwise channelized for non-productive consumption decisions. Unique to the Indian scenario is the compulsory linkage between formal credit and insurance. This is expected to have an impact on yield risks with the interaction between credit and insurance playing an important role. On one hand, credit (formal or informal) can be seen as an instrument of ex-ante income- smoothing or ex-post consumption-smoothing with regards to input and crop choice farm-level decisions that may be intended for risk mitigation. On the other hand, insurance provides for ex-post consumption smoothening. (Morduch, 1995; Swain, 2014). We will model household level crop input decisions, productivity observations, and the impact of credit availability therein, by employing the ICRISAT-VDSA dataset. To our best knowledge, ours is the first attempt at a formal estimation of the impact of institutional and non-institutional credit on crop yield distributions relative to a no-credit scenario. Moreover, we explicitly make a statistical distinction between the impact of formal and informal credit on agricultural productivity. The lessons from this exercise could be useful for understanding the implications of this linkage on the effectiveness of the crop insurance in India. The proponents of the compulsory coverage of loanee farmers under crop insurance have argued that this would increase formal credit penetration in the agricultural sector. However, the desirability of formal sector credit in terms of its risk mitigation impact on yield has not received enough attention. Our preliminary results show that this credit availability can indeed affect yield distributions through the source of credit and the type of crop.

PP38: Trends and patterns of agricultural orientation index across Indian states
(Abstract Id: A4-6-064)

Suvidya Patel

Center for Economic Studies and Planning, Jawaharlal Nehru University, Delhi, India
horizon841@gmail.com

Agriculture is the main source of employment for more than 50 percent of the total workforce in India and contributes to around 17 per cent of the country's GDP. Doubling of farmer's income is a priority not only for India but countries across the world have committed themselves to this under the Sustainable Development Goals. Given this, public expenditure on agriculture is essential to increasing agricultural productivity and farmer's income and thereby also reducing poverty and hunger. There are quite a few studies that look at the trends in public investment in agriculture both at the national and state level. However, most of the studies are based on level (or percentage) of public expenditure in agriculture which doesn't take into account the importance of agriculture to the state's economy. Consider two states A and B, with a similar share of government expenditure in agriculture but while agriculture contributes 10 per cent to A's GDP, agriculture's share in B's GDP is 20 percent. In this case, A would experience greater relative investment in agriculture than B. To deal with this problem, the IAEG-SDG panel recommended an indicator called Agricultural Orientation Index (AOI), which is included as a means of implementation indicator (2.a.1) under sustainable development goals. AOI is defined as the ratio of the share of government expenditure on agriculture to total government expenditure and the share of agricultural GDP to total GDP. It, thus, takes into account both the share of the government's expenditure in agriculture and its contribution to GDP. It

compares the government's contribution to the agricultural sector with the sector's contribution to the GDP. However, there is currently no study that calculates the AOI using Indian data sources and disaggregate it at state-level. Since agriculture is a state-subject, major expenditure on agriculture is done by states. But the state's expenditure on agriculture is not included in the AOI reported by FAO which takes only the central government expenditure on agriculture. The paper, therefore, constructs a time series of public expenditure (revenue and capital) on agriculture and allied activities for major Indian states and calculates the agricultural orientation index at the national as well as the state-level. It, then, presents an analysis of the trend of AOI in India and the patterns of inter-state variations and tries to find the causes for the same. Further, to check the robustness of the indicator, the paper looks at the sensitivity of AOI to agricultural growth, the overall growth of the economy and external shocks such as weather fluctuations and droughts.

PP39: Agricultural extension and development services for women in India: Identifying best path for sustainable development through multi-stage logit model
(Abstract Id: A4-6-012)

^aNiyati Joshi and ^bMahesh Nath Singh

^aMinistry of Statistics and PI Governemnt of India, National Sample Survey Office, New Delhi, India

^bMinistry of Health and FW, Government of UP, State Institute of Health and Family welfare , Lucknow, India

niyatijoshi.iips@gmail.com and maheshnsingh@gmail.com

The objective of this paper is to find how end level service providers of Agricultural Extension and Development Services can meet problems in identifying specific non-users at different stages of service delivery. A multi-stage Logit model is developed from NFHS (2015-16) data for women in India. The initial model is selected by Brown screening technique and for the final model, likelihood ratio statistic and Akaike information criterion is used. The study variables are knowledge and use of agricultural services, rural development programmes, impact of use of agricultural extension and services on health and social development of women, education and place of residence, Standard of Living Index(SLI) and cash earning.

Though spatial factors affect both users and non-users of Agricultural Extension and Development Services, SLI directly affect users of services while it operates through education for non-user women. The best model for user women is affected by use of services, education operating through standard of living. The study finds two different paths for sustainable development of these women with causation affecting future use of agricultural extension and services with separate policy concerns and suggests that paths to future use of services by user women may act as a social learning through diffusion process for non-user women.

PP40: Farm size and productivity in Indian agriculture: Recent evidences
(Abstract Id: A4-6-041)

Radha Ashrit

Department of Biotechnology, Government of India, New Delhi, India
radha.ashrit@nic.in

Recently, there has been an increased focus in India on making farming as a profitable venture through enhancing the farmers' income. Among various tools to enhance farmers' income,

improvement in productivity/yield of the crops to the fullest potential is an important one. In countries such as India, where the majority of farmers have only small and marginal land available for cultivation, understanding the relationship between farm size and per hectare yield assumes even more importance. Chayanov in 1926 was the first researcher to observe the existence of the inverse relationship between farm size and productivity in the Russian farm sector. In the Indian context, Sen, 1962, re-discovered the same pattern based on empirical evidence gathered from Farm Management Studies conducted on various agro-climatic conditions in the country during the 1950s. A number of studies examining the relationship have observed it be inverse, although there is no agreement among the researchers. Most of the studies in the Indian context are old and it has been hypothesized that the relationship might have undergone changes due to technological advances and policy impetus. The current study revisits the relationship between productivity per hectare and size using the plot level data from the Cost of Cultivation Surveys being conducted by Ministry of Agriculture and Farmers Welfare, Govt of India in the recent years (2001-2013). Specific objectives of this study are threefold. Firstly, to test the existence of a widely supported inverse relationship at the national level in recent years (2001-2013). Second, we test whether the relationship holds true across the crops and states or is merely observed at the national level. Third, we investigate the role played by various inputs in explaining the above relationship. Methodology As per the explanation offered by Sen, 1962& 1964 Indian agriculture is characterized by farmers who produce for the market as termed as big farmers and small farmers who can only able to produce for self-consumption. Further, small farmers are more labour intensive and use more traditional methods while big farmers are more capital intensive and use more of modern technology. Therefore, this study will be using the disaggregated data, ie using plot-level data to arrive at realistic results. We propose to study not only the classic relation between farm size and productivity but the relation of net returns too. A suitable methodology will be adopted to examine the role played by various inputs in explaining the above relationship. We also intend to examine the explanations provide in the literature for the so-called inverse relation phenomena and contribute in this regard. Data to be used A “Comprehensive Scheme for Studying the Cost of Cultivation of Principal Crops in India” known as Cost of Cultivation Scheme, is being implemented by the Govt of India through 16 Universities/ Institutions in 20 States to work out the estimates of the cost of cultivation/production in respect of selected 25 crops. This vital information is utilized for fixing the Minimum Support Prices (MSP) for various crops by the Govt. of India.

PP41: Food security and livelihood security in rural India
(Abstract Id: A5-7-035)

^aPrachi Misra Sahoo, ^aTauqueer Ahmad and ^bAnil Rai

^aDivision of Sample Surveys, ICAR-Indian Agricultural Statistics Research Institute,
New Delhi, India

^bCABin, ICAR-Indian Agricultural Statistics Research Institute, New Delhi, India
prachi.iasri@gmail.com, anilrai64@gmail.com, tauqueer.ahmad@gmail.com

Food security is defined as the availability of food and one's access to it. According to Food and Agriculture Organization (FAO) “A situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life.” The three components of food security are availability (having sufficient quantities of appropriate food available), access (having adequate income or other resources to access food), and utilization/consumption (having adequate dietary intake and the ability to absorb and use nutrients in the body). Food security exists when all people at all times have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. The four pillars of food security are: food availability, access to food, utilization and stability. Therefore, Food security in turn depends on livelihood security. Food security is the most important component of livelihood security which is the adequate and sustainable access to and control over resources, both material and social, to enable households to achieve their rights without undermining the natural resource base. Livelihoods can be made up of a range of on-farm and off-

farm activities, which together provide a variety of procurement strategies for food and cash. Thus, each household can have several possible sources of entitlement, which constitute its livelihood. These entitlements are based on the household's endowments and its position in the legal, political and social fabric of society (Drinkwater and McEwan, 1992). The risk of livelihood failure determines the level of vulnerability of a household to income, food, health and nutritional insecurity. Therefore, livelihoods are secure when households have secure ownership of, or access to, resources and income earning activities, including reserves and assets, to offset risks, ease shocks and meet contingencies (Chambers, 1989). In this study, an attempt has been made to develop livelihood index for different agro-climatic zones of India at district level based on available secondary data on the basis of six sub-indices which are indicators of Nutritional security, Infrastructure security, Agricultural security, Economic security, Health and Sanitation security and Food security in respective zone. A total of 57 variables were considered for this study. Finally, a composite integrated livelihood index has been developed which indicates the livelihood status of different agro-climatic zones in the country. Also, 103 districts of low agricultural productivity were identified within low livelihood regions. The results of this study were compared with the results of backward districts identified under wage employment program by the task force of Planning Commission of India. Further, influence of various factors on livelihood security of rural India has been studied by performing the sensitivity analysis which evaluates the contribution of each variable on Livelihood index. It also shows whether the variable influences the livelihood security negatively or positively.

PP42: Processing HCES data for apparent nutrient consumption analyses – The type of food matching matters
(Abstract Id: A5-7-029)

Ana Moltedo, Sofia Jimenez Calvo, Cristina Alvarez, Estefania Custodio, Maria Priscila Ramos, Talent Manyani, Carlo Cafiero
Statistics Division, Food and Agriculture Organization of the United Nations, Rome, Italy
ana.moltedo@fao.org, Sofia.jimenez-calvo@ext.ec.europa.eu, cristina.alvarez@fao.org, Estefania.custodio@ec.europa.eu, ramosmariapriscila@gmail.com, Talent.Manyani@fao.org, carlo.cafiero@fao.org

Background: When conducting analyses of apparent nutrient consumption using food consumption data from Household Consumption and Expenditure Surveys (HCES), the food matching is typically done considering items in their raw form (with the exception of multi-ingredient cooked dishes). This is because HCES collect information on consumption/acquisition during the recall period (typically 7 days). However, the content of vitamins and minerals is often altered (most likely reduced) during cooking. Therefore, not accounting for nutrient alterations in cooked foods may bias estimates of apparent nutrient consumption from HCES surveys. However, most food composition tables (FCTs) do not include the nutrient content for cooked foods, so recipes for cooked items would have to be created, but this requires specialized knowledge on food composition which analysts of HCES may not possess. **Objective:** To determine whether there is a significant difference in the average (apparent) consumption of 7 micronutrients when food consumption data are matched with raw items compared to matching them with items as consumed (raw or cooked).

Methods: We will evaluate food consumption data from the Kenya Integrated Household Budget Survey 2015-2016. The survey was conducted over a 12-month period, and it is representative at the national and county levels, as well as place of residence (rural and urban). We will match food items from the survey using two approaches: (a) with raw foods (traditional way), (b) with foods as commonly consumed (raw or cooked). For foods consumed cooked and mixed dishes, if nutrient composition is available for the cooked version/mixed dish then that will be preferred; otherwise, we

will account by alterations in nutrient content during cooking using retention factors. We will compile the nutrient content of foods from the 2018 Kenya food composition table. We will estimate the average per capita (apparent) consumption of 3 minerals (iron, zinc, calcium), and 4 vitamins (vitamin A, vitamin C, thiamine and riboflavin) at the national level and by 16 food groups. Separate analyses will be run for data matched with raw items and data matched with items considered as consumed. The absolute and percent difference between means will be calculated. Paired t-tests will be run to examine differences between means, with a p-value < .05 as the cutoff point for statistical significance.

Results: We expect the average (apparent) consumption of the nutrients analyzed to be higher when foods are processed as raw, as compared to when foods are processed as consumed. The largest differences are expected in the vegetables group for water-soluble vitamins (thiamin, riboflavin, and vitamin c).

**PP43: Reporting vitamin-A statistics using food consumption and production data:
impact of the unit of expression and the source of requirements
(Abstract Id: A5-7-028)**

Ana Moltedo, Cristina Alvarez and Carlo Cafiero
Statistics Division, Food and Agriculture Organization of the United Nations, Rome,
Italy
ana.moltedo@fao.org, cristina.alvarez@fao.org, carlo.cafiero@fao.org

Background: Vitamin A statistics can be derived from different data sources (individual and household consumption data, or food production data). These statistics are used for multiple purposes such as assessing and monitoring vitamin-A consumption in populations, nutrition-sensitive agricultural programs, determining availability of vitamin A in food production, and fortification programs. Many researchers produce vitamin-A statistics without clearly communicating what the indicator is measuring or estimating it wrongly. Objective: To analyze the effect, on vitamin-A estimates derived from Household Consumption and Expenditure Surveys (HCES) data, of using vitamin-A content in foods in micrograms of Retinol Equivalents (RE) or Retinol Activity Equivalents (RAE), and the criteria used to set vitamin-A requirements. Methods: We processed five national HCES from Eastern Africa, South-Eastern Asia and Southern Asia conducted between 2003 and 2010. We estimated vitamin-A apparent consumption, and the adequacy ratio (apparent consumption/Estimated Average Requirements) at national, urban-rural and income quintile levels using: (a) vitamin-A content in foods expressed in RAE and requirements in RAE published by the US Health and Medicine Division (RAE-HMD); (b) vitamin-A content in foods expressed in RE and requirements in RE published by FAO/WHO (RE-FAO/WHO); and (c) vitamin-A content in foods expressed in RE and requirements in RE published by the European Food Safety Authority (RE-EFSA). Results: As expected, expressing vitamin-A in RE produces higher estimates of vitamin-A apparent consumption than expressing it in RAE. The differences range from 144 to 902 in mcg/capita/day, and from 1.4 to 38.6 in percentage change. The vitamin-A adequacy ratios derived using RAE-HMD were the lowest ones, while the ratios estimated using RE-FAO/WHO were the highest ones. Using RE-FAO/WHO all population groups analyzed in all countries present an average apparent vitamin-A consumption above their requirements. Using RE-EFSA, most population groups in most countries have a ratio above 100. However, using RAE-HMD there are two countries where vitamin-A consumption in all population groups are below their requirements. Therefore, the level of vitamin-A consumption in a population could be classified as adequate or inadequate solely based on the unit of vitamin-A used (RE or RAE) and the source of vitamin-A requirements. Conclusions: When planning or monitoring vitamin-A policies and programs the selection of the source of requirements according to the criteria is crucial. Once the source of requirements is selected, estimates of vitamin-A consumption must be reported in the same unit of expression as the requirements. Statistics of vitamin-A expressed in different units are not comparable. Therefore

vitamin-A indicators used for monitoring programs or trends must be based on the same unit of expression and source of requirements. Furthermore, when reporting the level of inadequacy of vitamin-A it is of outmost importance to mention: the source and criteria of requirements, and the unit of expression used (RE or RAE) for the content of vitamin-A in foods.

PP44: Sampling methodologies for estimation of harvest and post-harvest losses of horticultural crops, livestock and fisheries
(Abstract Id: A6-8-027)

^aTauqueer Ahmad, ^bAnil Rai, ^aPrachi Misra Sahoo, ^aAnkur Biswas and ^aMan Singh

^aDivision of Sample Surveys, ICAR-IASRI, New Delhi, India

^bCentre for Agricultural Bioinformatics, ICAR-IASRI, New Delhi, India

tauqueer.khan01@gmail.com, anilrai64@gmail.com, prachi.iasri@gmail.com,
ankur.bckv@gmail.com, mansinghjuly59@gmail.com

One of the key programmatic areas of Food and Agriculture Organization of the United Nations (FAO) is the measurement of country progress towards achieving Sustainable Development Goals (SDG). The SDG in focus is target 12.3 which seeks to halve food waste at the retail and consumer levels and decrease post-harvest losses. The target and indicator belong to Tier III, i.e. those indicators for which an internationally agreed methodology is not yet developed and data are largely unavailable. The FAO through its International consultant has developed guidelines for countries to implement cost-effective data collection and improved methods for estimating post-harvest losses of grains. Grains are staple food products in almost all countries of the world, however higher loss levels are recorded on perishable commodities like fruits, vegetables, fish products and livestock products like milk and meat. In addition, these commodities have more diverse and variable supply chains, depending on country, commodity and end-market. Therefore, FAO signed a Letter of Agreement (LoA) with ICAR-IASRI in 2017 to develop ad-hoc guidelines to meet the growing demand from countries for methodological guidance and technical assistance. Under this LoA, suitable sampling methodologies for estimation of quantitative harvest and post-harvest losses of Fruits and Vegetables, Meat and Milk and Fish under Global Strategy have been developed. The sampling design proposed for selection of respondents in order to collect the data for assessment of harvest and post-harvest losses is stratified multistage sampling, the stages of sampling varying across commodities. Estimation procedures have been developed as per the proposed sampling designs for different channels/operations. All operations except storage are grouped under 'farm operations'. Storage is further sub-divided into farm level, godown/cold storage, whole-sellers, retailers and processing unit levels. The developed methodologies provide estimates of percentage loss along with percentage coefficient of variation (%CV) of the estimates at agro-climatic zone level/state/province level and national level. The estimates are the pooled estimates of percentage loss from the data collected through enquiry and actual measurement computed separately and then pooled through optimum pooling technique. Field testing of the methodology for estimation of quantitative harvest and post-harvest losses of fruits and vegetables was carried out in Mexico and of livestock produce in Zambia in 2018. Field testing in Mexico provides optimum pooled estimates of percentage loss (%loss) using enquiry and actual measurement estimates under different on-farm and off-farm operations in case of Banana in Cihuatlán municipality of Jalisco State and in case of Broccoli in Dolores Hidalgo and Valle de Santiago municipalities of Guanajuato State along with standard error and %CV of estimates of %loss under each operation. Field testing in Zambia provides estimate of %loss for two districts namely Choma and Mazabuka in case of milk and meat at on-site, off-site, storage and overall with %CV. Field testing in Mexico and Zambia concludes that the developed sampling methodologies for estimating harvest and post-harvest losses of fruits and vegetables as well as meat and milk will provide reliable estimate at Province level and National level.

PP45: Global trends in biodiversity for food and agriculture: Are we only losing diversity or also gaining some?
(Abstract Id: A6-8-007)

Vaishali Bansal and Vikas Rawal
Centre for Economic Studies and Planning, Jawaharlal Nehru University, New Delhi,
India
vaishalibansal02@gmail.com and vikasrawal@gmail.com

It is widely believed that increases in food availability, particularly as a result of modern breeding since the twentieth century, are associated with genetic erosion (see, for example, Frankel, 1970; Harlan, 1972, 1975; NRC, 1972; Thrupp, 2000, 2004; Vellvé, 2009). Given this, it is relevant to ask if global production of food has become more or less diverse over the past decades that have seen a significant increase in global production of food. This paper puts together empirical evidence on diversity of food production to examine the trends in biodiversity for food and agriculture. The paper uses data on food production, crop areas and food supply from FAOSTAT as well as compiles evidence from a review of large number of studies. The analysis finds that the trends are complex and, contrary to widespread belief, do not show a secular decline in diversity. A detailed analysis of trends of Simpson Indices of food production, crop areas and food supply shows that interspecies diversity of crop and aquaculture production has been on the rise in recent decades while interspecies diversity of animal-based food has declined. While there is some evidence of a continued loss of landraces, latest evidence shows that intraspecies genetic diversity has increased for some major crops. On the other hand, although efforts for conservation of animal genetic resources have gained strength, genetic erosion in major species of livestock remains a problem. Trends of prevalence of crop rotations, polyculture and mixed farming are likely to have been varied across regions and over time.

Changes in farming practices for intensification of agriculture, in particular excessive tillage and use of plant protection chemicals, is found to have adversely affected populations of subsoil organisms as well as birds, bees, pests and weeds.

PP46: Quantity Assessment of Melanin Pigmentation and Iron Concentration in Kadaknath Chicken Meat Reared in Jabua, Madhya Pradesh
(Abstract Id: A12-13-001)

^aI.S.Tomar, ^bR.Jayaraj and ^cMohammed Rahmathulla.V.P
^aKrishi Vigyan Kendra, Jhabua, Madhya Pradesh, India
^bKerala Forest Research Institute, Peechi, Kerala, India
^cMES College Nedumkandam, Kerala, India
kvkjhabua@rediffmail.com, jayarajravindran@gmail.com,
rahmathvp@gmail.com

Kadaknath chicken is a unique variety of black colored chicken commonly found in Jabua and in neighboring districts of Madhya Pradesh. This chicken is popular of its distinct and delicious taste of its meat and its use in folk medicine. Meat of this chicken contain high protein, very low fat and cholesterol are also significantly contributed in its popularity. From the literature it is found that fat content is 0.73 — 1.03% compared to 13 to 25% in most other chicken breeds. In addition to protein and fat content, other nutrient contents of this chicken meat are also relevant for scientifically establishing the dietary and medicinal importance of this meat. In this study, we scientifically established the presence and a quantitative assessment of melanin pigmentation (0.3645mg/gm, 0.4398mg/gm) and iron concentration (215.19mg/gm, 313.62mg/gm) in the cooked meat of Kadaknath chicken compared to 0.204mg/gm of melanin pigmentation and 104.90 mg/gm of iron concentration in cooked meat of broiler chicken.

PP47: Relevance of natural resource statistics a case of natural resins and gums from India
(Abstract Id: A7-9-005)

Raj Kumar Yogi, Nirmal Kumar and KK Sharma
DARE, ICAR-Indian Institute of Natural Resins and Gums, Ranchi, India
yogindri@gmail.com, nirmaldr04@yahoo.com, kewalkks@gmail.com

Natural Resins and Gums (NRGs) are important source of livelihood for tribal community across various states of India in the category of Non- Wood Forest Products (NWFPs) and lac is an important natural resin secreted mainly by Indian lac insect *Kerria lacca* (Kerr). India is the largest lac producer country in the World. In India, it is grown mainly in Jharkhand and Chhattisgarh. It is also grown in few districts of Madhya Pradesh, Odisha, West Bengal, Maharashtra and NEH region. Naturally produced lac and its value added products are utilized in paint and varnish, pharmaceuticals, perfumery, cosmetic, textile, handicraft, gems and jewelry industry. The scope of forecasting the production of sticklac (lac with the stick) using economic attributes was studied through simple linear regression and forecasting models. The data on sticklac production including kusmi and rangeeni strains during 48 years (1971-72 to 2017-18) were taken into consideration and the period was divided into pre intervention (1971-72 to 1998-99) and post intervention (1999-00 to 2017-18) scenario. Two major lac producing states namely Jharkhand and Chhattisgarh were selected purposively. Both states contribute more than 80% of total lac produced in India. Key factors like lag period production, market price, lagged market price, export, processing and value addition, etc. were included for estimation. Therefore, a network and linkages of key persons and resource persons from each stakeholder including producers, marketing agencies, primary processors, manufacturers and exporters has an immense role in providing relevant data. Field visits and surveys, Focused Group Discussions (FGDs), industrial visits, Common Interest Group (CIG) meetings, Farmer Interest Group (FIG) meetings have been conducted for higher precision of the estimates. Correlation analysis between rangeeni and kusmi strains revealed that lac production figures of Jharkhand has positive relation in pre intervention scenario while it had a negative during post intervention scenario and similar trends in relation of the production of two strains was found for national level statistics. But, Chhattisgarh showed positive relationship between the productions of rangeeni and kusmi strains of lac over the three scenarios. This may be due to the higher abundance of major lac host trees (*Schleichera oleosa*) in lac producing areas of Chhattisgarh due to which the pre intervention and post intervention scenario could not affect it significantly. Similar trends were inferred through the coefficients of simple linear regression models.

Coefficient of Determination (R^2) was ranged from 16% to 64%. The data generated have enormous application in policy planning to improve socio economic status of the growers and also priority setting for utilization of the funds with the national agencies (NITI Ayog, forest departments, NABARD, TRIFED, SHEFXIL, State level federations, NGOs and other line departments) and international organizations (World Bank, UNO, International Agricultural Organizations) for the benefit of forest dwellers in sustainable manner.

PP48: Trend analysis of hilsa (*Tenualosa ilisha*) landings in the middle stretch of the River Brahmaputra, Assam, India
(Abstract Id: A7-9-010)

^aA. K. Yadav, ^bK. K. Das, ^aB. K. Bhattacharjya, ^cR. K. Raman, ^cM. Naskar and

^cB. K. Das

^aICAR (DARE), ICAR-CIFRI Regional Centre, Guwahati, India

^bDepartment of Statistics, Gauhati University, Guwahati, India

^cICAR (DARE), ICAR-CIFRI, Barrackpore, Kolkata, India

yadav.anil.stats@gmail.com, kishoredas@gauhati.ac.in, bkbhattacharjya@yahoo.com,
rohan4741@gmail.com, malay.naskar@icar.gov.in, basantakumard@gmail.com

For effective fisheries management of River Brahmaputra in Assam, India as well as for formulating an effective management plan for sustainable fisheries development in the river stretch, it is important to know how the fish landing pattern has changed over the years. Such knowledge will facilitate the development of statistical forecasting models that predict fish catches, allowing for trend, and seasonality. Thus, we attempted for statistical significance of trend using data on hilsa (*Tenualosa ilisha*) fisheries, which was landed in Guwahati, the largest city in the northeastern Indian state of Assam situated on the south bank of River Brahmaputra. A 30-year (1987-2016) record of monthly landings of *T. ilisha* was analyzed using forecasting (trend) procedures in SAS 9.3 (R 3.5.1). Data on fish landings of the River Brahmaputra at Uzanbazar landing center, Guwahati collected by ICAR-Central Inland Fisheries Research Institute (CIFRI) was used for the study. The study revealed a significant ($p < 0.05$) decreasing trend of hilsa landings during the pre-monsoon (-90.8 kg yr⁻¹) and monsoon (-53.8 kg yr⁻¹) whereas an increasing trend was seen during the winter (31.4 kg yr⁻¹) season. On annual scale, hilsa landings have been significantly decreasing @ 146.7 kg yr⁻¹ during the study period. For forecasting of hilsa landings Seasonal Autoregressive Integrated Moving Average (SARIMA) methodology was used. On the basis of AIC and BIC values, the best model was found out as SARIMA (1,0,0; 0,1,1)₄. The mean absolute error (MAE), mean absolute prediction error (MAPE) and relative mean absolute prediction error (RMAPE) values for the fitted model were computed as 79.69, 0.085 and 8.56 respectively. The study indicates decline in abundance of prized hilsa fish in the River Brahmaputra, which calls for formulating and implementing effective fishery management plan for conservation of its stocks.

PP49: Bivariate Poisson regression modelling for analysing riverine plankton richness (Abstract Id: A7-9-004)

^aRohan Kumar Raman, ^aMalay Naskar, ^bS.K. Sahu and ^cB.K. Das

^aAgricultural Statistics, ICAR-CIFRI, Kolkata, West Bengal, India

^bElectronic Instrumentation, ICAR-CIFRI, Kolkata, West Bengal, India

^cFisheries Aquaculture, ICAR-CIFRI, Kolkata, West Bengal, India

Rohan.Raman@icar.gov.in, Malay.Naskar@icar.gov.in,
sksahu_2k@yahoo.com, basantakumard@gmail.com

Bivariate Poisson regression modelling (BPRM) is used to estimate the effect of explanatory variables on two depended count response variables. It provides a suitable tool to assess the aquatic ecosystem parameters, where response data, such as species richness of fish, phytoplankton, zooplankton (i.e., in non-negative numbers). Further, in aquatic ecosystem, it is evident that the phytoplankton and zooplankton richness are correlated due to their biological relationship, and they are highly influenced by the water quality parameters. So, to examine the correlation between phytoplankton and zooplankton richness in the river systems, the secondary data on water quality and phytoplankton and zooplankton richness of four rivers Beas, Ganga, Ravi and Sutlaj of Western Himalayan region were taken for model development and analysis. A total of 10 water quality variables (e.g., Water Temperature (°C), Dissolved oxygen (mg/l), Specific conductivity (μS/cm), Turbidity (NTU), Total dissolved solids (mg/l), pH, Chloride (mg/l), Alkalinity (mg/l), Hardness (mg/l), Nitrate (mg/l) and phosphate (mg/l)) along with plankton and zooplankton richness (no.) recorded at 42 sites of all the four rivers have been considered for modelling. Factor analysis was used for the covariates selection and BPRM for the plankton and zooplankton. AIC is chosen as model selection criterion. Results of analysis showed that a positive correlation ($r = 0.36$) exist between the plankton and zooplankton

community. Three factors have explained more than 75% variability of water quality variables. Three important water quality parameters such as conductivity, dissolved oxygen and phosphate were identified as the dominant water quality parameters in the river system. Out of these three identified water quality parameters, dissolved oxygen is found to be the most influential covariate having minimum AIC value of 690.56 to explain phytoplankton and zooplankton richness as well as their correlation. The advantage of using BPRM is that we have successfully quantified site-specific correlation between phytoplankton and zooplankton richness in river system, which is being reported first time. It indicates that site-specific correlation between phytoplankton and zooplankton richness in the river Sutlej is relatively lower than that in Ganga, Ravi and Beas.

PP50: Rainfall analysis for storage and irrigation planning in Rajasthan, India
(Abstract Id: A8-10-033)

Bhim Singh
Basic Science, Sardar Vallabhbhai Patel University of Agriculture & Technology,
Meerut, India
bhimsingh1@gmail.com

A study was carried out to analyze the rainfall data for storage and irrigation planning under humid south-eastern region of Rajasthan using a time series record for 32-year (1980-2011) periods. It was observed that most of the years under observation were having adequate rainfall for all round the year crop production provided the water were collected during the rainy season. The area received 921.5 mm annual rainfall out of which 92% occurred during southwest monsoon (June-September) season. Of the total study period of 32 years, 19% were drought years, 66% were normal years and the remaining 15% were the abnormal years. The annual rainfall during the period showed negative trend (-6.955 mm/year). It showed decreasing trend (-7.782 mm/year) during the month of August and positive trends with 0.864, 3.909 and 1.192 mm/year, respectively, during month of June, July and September. The analysis generally showed that water deficit appeared during the period of November up till May and rain water was excess during the period of June up till September. During these months, rain water can be stored with the help of rainfall harvesting system. If only 50% of total rain water is collected, it forms approximately 44.16 lacs litres of water on a unit hectare basis of land. This rainfall water will be adequate for all rounds the year crop production with conservation of rain water and judicious use of rain water resources.

PP51: Item Sum Techniques for Quantitative Sensitive Estimation on Successive Occasions
(Abstract Id: A9-14-004)

Kumari Priyanka
Department of Mathematics, Shivaji College, University of Delhi, New Delhi, India
priyanka.ism@gmail.com

The problem of the estimation of quantitative sensitive variable using the item sum technique (IST) on successive occasions has been discussed. IST difference, IST regression, and IST general class of estimators have been proposed to estimate quantitative sensitive variable at the current occasion in two occasion successive sampling. The proposed new estimators have been elaborated under Trappmann et al. (Journal of Survey Statistics and Methodology, 2, 58–77, 2014) as well as Perri et al. (Biometrical Journal, 60, 155–173, 2018) allocation designs to allocate long list and short list

samples of IST. The properties of all proposed estimators have been derived including optimum replacement policy. The proposed estimators have been mutually compared under the above mentioned allocation designs. The comparison has also been conducted with a direct method. Numerical applications through empirical as well as simplistic simulation has been used to show how the illustrated IST on successive occasions may venture in practical situations.

**PP52: Scrambled Response Techniques in Two Wave Rotation Sampling for
Estimating Population Mean of Sensitive Characteristics
(Abstract Id: A9-14-003)**

Pidugu Trisandhya
Deapartment of Mathematics, Deapartment of Mathematics, Shivaji College, University
of Delhi, New Delhi, India
trisandhya.09@gmail.com

Present work is an attempt to use non-sensitive auxiliary variable and scrambled response techniques (SRT) to estimate population mean of a sensitive variable. A class of estimator is proposed to estimate the population mean of a sensitive variable in sampling over two successive waves. Various members of the proposed class of estimators has been discussed. The proposed class of estimator has been analysed theoretically as well as empirically. It has been compared with modified general successive sampling estimator and with some of members of its own class. Simulation study has also been discussed.

**PP53: Enabling SAAS model for improving the effectiveness of teaching-learning
process - A case study at NAARM
(Abstract Id: A10-11-017)**

^aVV Sumanthkumar, ^bN Sivaramane, ^cSK Soam and ^dCh Srinivasa Rao
^aEducation System Management Program, ICAR-NAARM, Hyderabad, India
^bABM, ICAR-NAARM, Hyderabad, India
^cJoint Director, ICAR-NAARM, Hyderabad, India
^dDirector, ICAR-NAARM, Hyderabad, India
sumanth.naarm@gmail.com, sivaramane@naarm.org.in, sumanth@naarm.org.in,
cherukumalli2011@gmail.com

The National Academy of Agricultural Research Management (NAARM) was established by the Indian Council of Agricultural Research (ICAR) at Hyderabad, in 1976, to address issues related to agricultural research and education management. Keeping in view the increasing national and global need to integrate agriculture with agribusiness for raising rural incomes, and the increased emphasis on the creation, dissemination, application and exchange of knowledge in this vital area, the Academy has initiated post graduate education programmes and set up an Agribusiness Knowledge Centre to facilitate ICT based information provision to different stakeholders. In the above mentioned scenario, NAARM also conducting many training programmes/courses over the year and there is lot of time and resources being invested into arranging physical machines and software. There is a need of maintaining specific set of software required for each course/training. The Coordinators/Teachers of the training programmes/Courses has to ensure beforehand that all the machines are working fine and all the software required for that training got installed in all machines and working without any issues and this has to be done before the start of trimester. This requirement of preparedness for training programmes/Courses has been avoided completely while offering a course “ERP for Agribusiness”, by establishing a cloud which can provide Software as a Service (SaaS) to the students of the course.

The templates of identified open source software being made available to the students and the student can select the software based the features available in that particular ERP Software. These ERP instances are available throughout the trimester and can be accessed from anywhere. Each student was provided Individual and Independent Cloud based ERP instances for improving the effectiveness of teaching - learning process. Students were encouraged to take different software so as to understand the nuances of different available software. Feedback from the students has shown the usefulness of the methodology as it is practical and helps them to implement the enterprises they join after completion of the course. These independent cloud ERP software instances solved many challenges aroused when single local instances were provided. These issues have been completely avoided by establishing a cloud and providing individual and independent instances to each and every student which enhanced effectiveness of Teaching-Learning process.

**PP54: Identifying small-scale food producers: Evaluating alternative methodologies using the situational assessment survey of agricultural households in India
(Abstract Id: A11-12-004)**

Prachi Bansal
Centre for Informal Sector and Labour Studies, Jawaharlal Nehru
University, Delhi, India
bansalprachi52@gmail.com

The relationship between farm-size and productivity has been a very important issue of debate in Indian agriculture. Starting from Sen (1964), a large body of literature has emerged that debated the relationship between farm size and productivity. This debate has had an important bearing on the scholarship on a range of issues related to agrarian conditions including on effectiveness of redistributive land reforms (for example, Griffin et al., 2002), distributional effects of state support to agriculture and adoption of technology by small-scale producers. Measurement of farm size has been one important issue in this debate as several scholars have pointed out that productive potential of land varies greatly on account of variations in soil quality, agro-ecological conditions, availability of irrigation and capital investment. As a result, it has been noted that physical extent of land is not a good measure of scale (FAO, 2017, Utsa, 1971 and Utsa, 1972). This problem particularly affects national studies of relationship between farm size and productivity in India because of wide regional variations in productive potential of land. The 2030 Agenda for Sustainable Development has set a global target to double productivity and incomes of smallholder food producers by 2030 (Target 2.3). For this purpose, the Inter-Agency and Expert Group on the Sustainable Development Goals (IAEG-SDG) has proposed a new methodology for identification of the small-scale food producers. This method differentiates small-scale food producers on the basis of both physical size and economic size. As per this new definition, Small-scale food producers are identified through a three-step process. i) First, smallest producers that account for 40 per cent of the distribution of land and smallest producers that account for 40 per cent of livestock endowment are identified. These are the small-scale producers as per the physical extent. ii) In the second stage, producers with smallest value of output accounting for a total of 40 per cent of value of output are identified. These are small-scale producers as per the economic size. iii) An intersection of the two sets, with a ceiling of PPP US\$34,387, is treated as the set of small-scale food producers. The above definition to identify small-scale food producers is to be used by all countries to provide estimates for SDG indicators 2.3.1 and 2.3.2. This paper applies the above definition to the data from the Situational Assessment Survey of Agricultural Households (NSSO, 70th round) to assess its robustness and to use it to explore the relationship between farm size and productivity. The study examines relationship between farm-size and productivity using physical size, economic size and the combined (physical and economic) size as different measures of scale. The analysis is relevant to the debate on identification of small-scale food

producers and throws light on the characteristics of small-scale food producers in India.

**PP55: Measuring SDG 6.4 - Water productivity and water stress in
Indian Agriculture: Possibilities and Limitations
(Abstract Id: A11-12-013)**

Ankur Verma
Center for Economic Studies and Planning, JNU, New Delhi, India
ankurv986@gmail.com

Water is a key input for any economic activity. With increasing population and the patterns of economic growth, pressure on freshwater resources has intensified and water sustainability has become one of the major challenges in the 21st century. Given the importance of sustainability of water use, Target 6.4 of Sustainable Development Goals aims to substantially increase water-use efficiency and reduce water scarcity. Improvements in the agricultural sector, which accounts for more than 80 per cent of total freshwater withdrawals, are key to making progress towards this target. SDG Indicator 6.4.1, water-use efficiency, essentially measures water productivity in different sectors and is defined as the value added per m^3 of water artificially applied and used in different economic activities. While this indicator uses a specific definition of water productivity, several other definitions have also been used in the scholarly literature on water productivity. Similarly, there are several matrices that measure water scarcity and stress. The paper reviews the existing literature regarding the measurement of water productivity and water stress, and in that context, discusses the methodology and meaningfulness of the SDG indicators 6.4.1 (water-use efficiency) and 6.4.2 (water stress). Water productivity is a partial measure of productivity and has the usual limitations of partial measures of productivity. In case of agriculture, it does not control for either variations in agro-climatic conditions or other factor inputs. This, in particular, limits the utility of cross-sectional comparisons of agricultural water productivity across regions with very different agro-climatic conditions. Comparisons over time, however, are likely to be less problematic and the indicator may be a useful guide for tracking improvements in efficiency of water use. The paper also presents an analysis of water productivity and water stress in India using data from AQUASTAT, a database maintained by FAO. This analysis shows that water productivity in India, at US\$1.9/ m^3 of water, is among the lowest in the world while the level of water stress, 66 per cent, is high. Water productivity is particularly low (US\$ 0.3/ m^3 of water) in agricultural sector in India. The paper checks for robustness of these results for agriculture by using alternative measures of water productivity. The analysis shows that India has reached a high level of water stress at a very low level of water-use efficiency. This has serious implications for economic development of the country, and in particular, of the potential of agricultural growth. There can be two ways of increasing water productivity in agriculture and reducing water stress on account of agriculture: (i) shifting to crops with high value of output and low water requirement and (iii) improving productivity of water use in each crop. Assessing the potential of improving water productivity through these strategies requires granular data on water withdrawals and water use. The paper presents a review of water statistics in India and identifies gaps for such an analysis.

**PP56: Some Inferential Aspects of Latin Square Designs in the Presence of Row and
Column Neighbour Effects
(Abstract Id: A12-13-003)**

^aSobita Sapam, ^bBikas K. Sinha and ^cNripes K. Mandal
^aDepartment of Statistics, Manipur University, Imphal, Manipur, India
^bRetired Faculty, Department of Statistics, Indian Statistical Institute,

Kolkata, West Bengal, India
Retired Faculty, Department of Statistics, Calcutta University, Kolkata,
West Bengal, India
sobita1@yahoo.com, bikassinha1946@gmail.com,
mandalnk2001@yahoo.co.in

In a recent study, Sobita Sapam et al (2019) examined the nature of changes in the properties of the error functions and estimates of treatment contrasts in the presence of row and column neighbor effects. This was done with reference to Latin Square Designs (LSDs) of order 4. In this study we carry out the same for LSDs of orders 5 and 6. Briefly speaking, whereas the error functions are unaffected, treatment contrasts estimates are no longer unbiased in the presence of neighbor effects unless some conditions are satisfied. Presence of neighbor effects poses a 'threat' to the standard data analysis for an LSD.

**PP57: Randomization in agricultural experiment: When to use & what to use
(Abstract Id: A12-13-017)**

Gayatri Vishwakarma
Biostatistics, Indian Spinal Injuries Centre, New Delhi, India
gayatri.singh.v@gmail.com

It is understandable that randomization helps ensure that measurements of experimental variation are unbiased by destroying correlations among errors. However it is difficult to identify appropriate type of randomization technique for a study. Validity of statistical analysis strongly depends on the validity of the assumed model. Unless the trend is well known, which will infrequently be the case in agricultural experiments, it is recommended that better to use blocking in combination with randomization in some designs. Experimental layouts can be either completely randomized or blocked arrangements. This paper discusses that there are several factors which help determine correct randomization method including two most important one i.e. objective of study and study design.

**PP58: Statistical considerations in agricultural research studies
(Abstract Id: A12-13-030)**

^aKaran P Singh and ^bGayatri Vishwakarma
^aBiostatistics, Epidemiology and Biostatistics, The University of Texas Health Science Center
at Tyler, Tyler, USA
^bBiostatistics, Indian Spinal Injuries Centre, New Delhi, India
karan.singh@uthct.edu, gayatri.singh.v@gmail.com

Investigators conducting research at centers related directly or indirectly to agriculture often ask statisticians, "Does new treatment or intervention work? Or can we get something equivalent to the existing one just as effective and more economical?" Therefore, designing a research study appropriately is very important. For doing so, the use of essential principles of randomization plays a very significant role. In this presentation, different methods of randomization, including their advantages and disadvantages are briefly discussed. Statistical considerations for research studies from beginning to end using practical examples are presented including randomization.

PP59: The production of pineapple in Manipur- A statistical perspective
(Abstract Id: A12-13-008)

^aChangamayum Girija Devi and ^bS Loidang Devi

^aDepartment of Statistics, Manipur University, Imphal, India

^bDepartment of Statistics, D M College of Science, Dhanamanjuri University,
Imphal, India

gijachang01@gmail.com and loidang023@gmail.com

Agriculture plays a vital role in India's economy. Agriculture is the main occupation and largest productive unit in Manipur economy. More than half of the total working populations of the state are directly dependent on Agriculture. Manipur is suitable for the development of horticulture. In north eastern India, Manipur is one of the leading pineapple producing state. Pineapple has the second largest production next to rice. An increase in production helps in promoting the economic welfare of the state and greater income generation. Hence in view of this consideration, it is necessary to discuss the present trend of the pineapple production so as to enable the state to formulate appropriate strategies for sustaining and enhancing the production. The main objective of this study is to fit ARIMA model to forecast the production of pineapple. This study is based on the secondary data of pineapple production, area and productivity in Manipur over the period 1997 to 2016. From the study, it is found that ARIMA(1,1,0), ARIMA(0,1,0) and ARIMA(1,1,0) are the best model to forecast the production, area and productivity of pineapple respectively in Manipur. From this study, the comparison between the original and forecasted values shows the same manner indicating that the fitted model is statistically well behaved and suitable for forecasting the production, area and productivity of pineapple in Manipur. Finding shows that the analysis carried out in the existing data is quite satisfactory.

PP60: Mapping of agricultural production units (culture, livestock, forestry and fishing)
(Abstract Id: A2-2-019)

Tall Ibrahima

Firms Statistic Office, National Agency of Statistic and Demography,
Dakar, Senegal

ibrahimatallise@yahoo.fr

The Mapping of Farms is the first phase of the agricultural component of the general business census in Senegal. It aims to establish a reference tool for collection staff in the field, by identifying and geographically identifying the units to be investigated during the collection phase. In the three regions of the country, Saint-Louis, Louga and Matam, the cartography made it possible to delimit 727 census zones in which 196320 farmers are identified who practice exclusively culture, livestock, horticulture, culture combined with livestock farming (agro-pastoralists), or other agricultural activities (aquaculture, forestry, fishing). It was geo-referenced a number of 75882 crop farms, 93387 livestock farms, 21837 horticultural farms, 4183 agro-pastoral units, 299 units related to other agricultural activities. As part of the transhumant breeding, it was identified 1728 zones of herd concentration and 1848 water points.

PP61: A systematic approach for generation of agricultural statistics integrating remote sensing, GIS and survey in hilly regions
(Abstract Id: A2-2-039)

^aPrachi Misra Sahoo, ^bAnil Rai, ^aTauqueer Ahmad and ^cB.K.Handique

^aDivision of Sample Surveys, ICAR-Indian Agricultural Statistics Research Institute,
New Delhi, India

^bCABin, ICAR-Indian Agricultural Statistics Research Institute, New Delhi, India

^cAgriculture, NESAC, Shillong, India

prachi.iasri@gmail.com, anilrai64@gmail.com, tauqueer.ahmad@icar.gov.in,
bkhandique@rediffmail.com

Hilly regions of North-East and some other Union territories of India does not have well defined scientific methodology for estimating crop area and production as it exists in other parts of the country. In these areas, the statistics are collected on the basis of ad-hoc methods from the village headman which are purely unscientific and non-statistical and unreliable. This is due to the unique problems existing in hilly regions like uneven terrain, undulating topography, non-accessibility, less percentage of area under cultivation, terraced farming, jhum cultivation, smaller field sizes etc. Remote Sensing techniques have the potential to provide information on agricultural crops quantitatively, instantaneously and above all non-destructively over large areas. But crop acreage estimation methods and yields at regional scales in hilly regions even using satellite data still remains a challenge from the entire country because of cloud cover in the satellite imagery, misclassifications due to undulating topography and topographic geometry, area falling under hill shades or valleys and detection of smaller fields due to spatial resolution of the sensors. Therefore, a sample survey or remote sensing alone is not capable of providing area estimates in hilly regions unlike in plains with reasonably good accuracy. In view of this, a need was felt to develop a systematic approach based on scientific methodology with strong statistical background for the generation of agricultural statistics which is capable of providing reliable estimates of area and production under different crops in these regions integrating Remote Sensing, GIS and Survey in Hilly regions. A northeastern hilly state namely Meghalaya which has diverse topography, cloud cover, very less area under cultivation and variety of crops grown has been taken up as the representative state for this study and the crops covered are rice, maize, potato, ginger, pineapple and. Satellite data of IRS-1D and IRS-P6 LISS III was used for the study for four districts of Meghalaya. Using the IRS P6 LISS-3 data. In Meghalaya different crops are grown at different elevations like paddy is grown in valleys, pineapple is grown on hill slopes, potato and ginger are grown on the relatively flat surface on the hilltop. Thus, elevation plays a significant role in crop growth in this region.

Therefore, the usual stratification criterion based on administrative boundaries fails to provide accurate/ efficient strata and hence such stratification criteria needs to be developed which takes into account both elevation and extent of cultivation which are the two most important factors influencing the acreage under a crop. For spatial stratification, cropped area layer was extracted from Land Use land cover (LULC) maps, and elevation layer, obtained from DEM was used. Both these layers were classified into three categories as Low, Medium and High. Suitable estimator for area under crop at district level was obtained. Suitable estimates of area under each of these crops were developed. Further to enhance the accuracy of the result, the survey was again conducted in two different seasons to cover all the crops by retaining 50% previous season.

PP62: Building a systematic approach to agricultural statistics
(Abstract Id: A1-1-011)

Building a Sustainable Agriculture Statistics System for Fiji on the

existing infrastructure, network and resources
Sainiana Kirisitiana
Fiji Agriculture & Rural Statistics, Ministry of Agriculture, Suva, Fiji
sainiana.kirisitiana@govnet.gov.fj

In Fiji, the agriculture services provided by the Ministry of Agriculture is decentralised across the fourteen provinces and districts. All province has two or three Agriculture stations equipped with basic office apparatus's (computers, whiteboards, tables and chairs) that supports the delivery of service of the agriculture extension officers. The allocation of Agriculture stations in a province depends on the geographical spread and number of farmers. The extension officers are the forefront of the Ministry to the farmers or public. They are the one that has better network connection and good relationship with farmers at different level. This is always considered as a strength of the Ministry in terms of the cost effectiveness and economical approach of collecting agriculture (crop & livestock) data through the extension officers. Likewise, their technical agriculture know-how is an advantage that always assures quality estimation of production data. Since the Government Computers are all connected to a Govnet portal, therefore, the idea of designing a statistical system using the "Shared Drive" tool is highly considered. Agriculture Data collected from farmers will be recorded and updated by the Extension Officers in a designed matrix saved in their respective Shared Drives which has the frame or listing of the farmers within their responsible areas. This approach won't allow more additional cost of setting up IT system and infrastructure since it is already available. This will allow extension officers, supervisors, statistic officers and managements to share or access data freely without emailing or printing and allows more collaborative work. There will be strategies in place and other technical measures on security of data in a Shared Drive. This will assist the extension officers in all areas of his services; data collection, monitoring, farm visits and development plans. Capacity building on agriculture statistics is an area on which Fiji will improve for the sustainability of the system in the future. The existing structure, network and resources, is a platform of building a sustainable agriculture (crop & livestock) statistics system which is cost effective, simple and user friendly in nature.

PP63: Optimising the production of consumption data in the Pacific region
(Abstract Id: A1-1-039)

Michael K. Sharp
Statistics for Development Division, Pacific Community (SPC), Noumea,
New Caledonia
michaels@spc.int

Household income and expenditure survey (HIES) is the primary data source to estimate poverty prevalence and to rebase the consumer price index and gross domestic product in the Pacific region. More recently, HIES data are being used as a secondary source to estimate dietary energy consumption and to perform food security and nutrition analysis. Since 2011, a regionally standardised HIES has been implemented in the Pacific region where consumption data are captured through a household-based two-week food acquisition diary. Empirical evidence suggests the diary does not perform well due to low monitoring and respondent fatigue resulting in a trend of declining access to food over the diary period. Additionally, the standardised HIES instrument does not collect opening and closing stocks of food before and after implementation of the 14-day diary, which prohibits the estimation of apparent consumption. Furthermore, the standardised HIES instrument does not have specific modules on meal partakers and food away from home, which anecdotally appear to affect consumption estimates considering the Pacific culture of sharing food as well as apparent increasing access to pre-prepared food consumed away from home. In response to these

challenges with the current HIES methodology, the Pacific Community (SPC), the World Bank, the Food and Agriculture Organisation of the United Nations (FAO), and other partners, conducted an experiment in the Republic of the Marshall Islands (RMI), which was hosted by the Economic Policy, Planning and Statistics Office (EPPSO). The 'RMI HIES Experiment' is designed to guide future improvement to the regionally standardised HIES methodology, which aimed to test: i. the use of technology, in the form of tablets and satellite phones, to capture and transfer data in remote Pacific islands; ii. the inclusion of complementary survey modules, including stocks, food away from home and meal partakers; and iii. different methodologies to collect consumption data through HIES. The different methodologies for collecting consumption data include varying forms of high and low monitored diaries with data being collected using paper and tablets; and varying forms of seven-day consumption recall with data being collected using tablets. This paper presents the results of the RMI HIES Experiment with a focus on the implication of different methodologies to collect consumption data and the addition of complementary survey modules on the estimation of, among others, poverty and prevalence of undernourishment. The results of the RMI HIES Experiment will guide recommend methodology for conducting HIES in the Pacific region under the 2030 Agenda for Sustainable Development, which will produce data to report against indicators under Sustainable Development Goals 1 and 2.

PP64: Methodology proposal for anonymising and dissemination of statistical survey data: Case of agricultural survey data
(Abstract Id: A3-5-012)

Bourama Mane
ANSD, Dakar, Senegal
ibmane@gmail.com

Agriculture is the main resource-producing activity for the economies of many African countries. Despite its central place, it is often difficult to define boundaries and quantify production on the basis of reliable statistics. The need to have a well-functioning information system that would help to process data on these companies is a lever for economic recovery and direct action on Gross Domestic Product (GDP). This business support to informal sector enterprises that must be create by the states, will depend on the available information on the companies characteristics, the economic situation through the turnover and the employment, access to finance, constraints and difficulties, access to public procurement, availability of premises for all economic units in the sector. The statistical services have initiated important projects to make reliable data available to the authorities, the private sector, civil society, the general public and technical and financial partners. A set of indicators must be defined and adopted to better measure progress and evaluate the public policies results. An example of an indicator of informal sector importance is the bank access low rate that persists in sub-Saharan Africa (not more than 20% according to the World Bank). Thus, those who do not have an account otherwise manage their financial flows, through savings, also informal. However, official structures of statistical production increasingly face legal, technical and organizational constraints in the management of these types of data collected from individuals, households and businesses. Indeed, data from this informal sector usually consists of personal content. With the interest shown by donors such as the International Monetary Fund (IMF) in this sector and the advent of Open Data [1], access and dissemination of this data for the purposes of planning, monitoring and activities are becoming a necessity, in a context marked by a desire on the part of the authorities to accelerate economic growth [2]. In addition, the data file formats at the National Statistical Institutes (NSOs) generally determine how to publish the information they contain. Without using the NIS web portals, data collection projects, especially those funded by donors, are increasingly integrate a data dissemination method for the survey. These dissemination methods do not generally favor quick

access to information and do not allow linking of data for in-depth analysis processing. These questions more than ever topical constitute our work subject whose results are presented in this article entitled: methodology proposal for statistical data anonymization and dissemination in linked open data case of agricultural survey data. For the proposed approach validation, microdata from the survey on financial inclusion in Senegal were used to assess the quality of data from the anonymization process. The satisfactory results obtained were subsequently confirmed by applying the procedure to data on national employment surveys, poverty monitoring and Senegalese general population census.

PP65: Can knowledge management and communication kindle better compliance in marine fisheries governance? A case analysis from Kerala
(Abstract Id: A3-15-003b)

Reshma Gills and C Ramachandran
SEETTD, ICAR-CMFRI, Kochi, India
reshma1818@gmail.com, ramchandrancnair@gmail.com

Marine fisheries ecosystem is very complicated due to many social, ecological, economic, policy-oriented, management and biophysical aspects. The common property nature with state as the de-jure owner, makes its sustainable management as a complicated affair. These intricacies point to the need of knowledge management practices with effective communication of the policy interventions in the context of local ecological knowledge, traditional rule systems, stakeholder preferences and mindsets of department official's government officials for better governance and compliance. This paper highlights, how effectively the statistical methods had been used in selection and designing of a communication tool, knowledge management, collection and interpretation of gender data and impact analysis of enforcement in the marine fishing sector of Kerala. A conceptual frame work has been developed for the knowledge management regime. Impact of the enforcement was analysed with respect to the number of impounding reported and the revenue generated during the last five years. It could be surmised from the results that the changes (increased or decreased) in number of impounding reported in the costal districts may due to various positive or negative factors like the active and vigilant monitoring of the State fisheries enforcement wing after the implementation of KMFR Rules 2017, social capital-led enhanced level of compliance from the fisherfolks, political meddling etc.

PP66: Forecasting of milk production and milk prices using secondary data: Issues of data collection, data integration and modeling
(Abstract Id: A4-6-054)

Sivaram M, Dixit PK, Gayathri S and Rakesh B
Southern Regional Station, ICAR-National Dairy Research Institute, Bangalore, India
sivaram.ndri@gmail.com, drpkdixit@gmail.com, gayathrisandralla@gmail.com,
rakeshbasavraj@gmail.com

The forecasting of milk production and milk prices are very often carried out using annual growth rates based on past data. The multivariate forecasting of milk production and milk prices requires time series database on their endogenous and exogenous variables by sourcing data from different agencies. However, there are many challenges in undertaking such work which include data availability, data quality and data integration. In this paper, we present the efforts made and

difficulties faced while developing a database for dairy sector of Karnataka State, India. We also present the efforts made on using Vector Autoregressive models for forecasting milk production and milk prices by considering endogenous variables. In the case of forecasting of milk production, herd efficiency ratio and milk productivity of cattle were the predictors. In the case of forecasting of milk prices (procurement and retail prices), the prices of feed and labour wages were the predictors. Some model building issues of forecasting of milk production and milk prices are also highlighted.

**PP67: How effective is targeted public distribution system of India
(Abstract Id: A5-7-010)**

Mukesh and Neha Srivastava
Government of India, National Sample Survey Office, New Delhi, India
mukesh.iss.goi@gmail.com and Srivastavaneha19@gmail.com

Food Security is defined as the state of having reliable access to a sufficient quantity of affordable, nutritious food. The fact that food security is the responsibility of the State has been reaffirmed on the global fora time and again. In India, the Public Distribution System evolved before 1960's and was expanded in 1960's and 1970's as a food security initiative to curb the shortages of the time. Post green revolution, as India became the major grain bowl of the world, food shortages no longer remained a concern for the general population. Thus, in the year 1997, the PDS was modified as Targeted Public Distribution System (TPDS) in order to provide food security to the poor. Over the years, the Targeted PDS (TPDS) has become an important instrument of governance aimed at rendering economic benefits to the population below the poverty line by delivering minimum requirements of food grains at highly subsidized prices. Periodic assessments of TPDS as a food security initiative have been carried out in India by organizations like the NITI Aayog, Agriculture Ministry and FAO of United Nation. However, an evaluation of how the effectiveness of TPDS has fared over the last 2 decades, both in terms of 'availability of food grains' and 'economic benefit / support rendered', is much needed. In this paper, intend to study the effectiveness of TPDS as a food security initiative for the poor (i.e. the households belonging to the lowest quintile class of consumption expenditure). The study has been carried out from 1999– 2000 (just after introduction of TPDS) to 2017-18 based on the data on Household Consumption Expenditure Surveys conducted by National Sample Survey office, Government of India during 1999-2000, 2004-05, 2009-10, 2011-12 and 2017-18. The effectiveness of the TPDS will be studied with two approaches. In the first approach, comparison between the per capita quantity consumption of food grains and expenditure due to TPDS and other sources will be carried out for the households belonging to the lowest quintile class of level of living. In the second approach, comparison of per capita quantity consumption of food grains and expenditure between 4 different categories of poor households will be made to ascertain the difference made by TPDS. The categories being 'households who are BPL card holders and avail PDS', 'households who are Antyoday card holders and avail PDS', 'households which avail PDS at normal rates' and 'households which do not avail PDS'.

**PP68: Impact of policy interventions on price index of Finger Millet (Ragi) in India
(Abstract Id: A4-6-059)**

Achal Lama, K N Singh, Ravindra Singh Shekhawat and Bishal Gurung
F&ASM, ICAR-IASRI, New Delhi, India
achal.lama@icar.gov.in, knsingh@iasri.res.in,
ravindra.shekhawat@icar.gov.in, vsalrayan@gmail.com

Millets are the major substitute for cereals such as rice and wheat. For developing country like India it holds immense importance as its cost of production is low and has high nutritional values. Various policy interventions are made by government of India from time to time to popularise its consumption and production. Few major policy interventions were made in last decade and inclusion of coarse cereals under Food Security Bill is one among them. Keeping this in mind, the study focuses in impact of policy interventions on the price index of Ragi. The data was collected from Office of the Economic Adviser, Ministry of Commerce, Government of India (www.eaindustry.nic.in) and it contained 160 data points (January, 2005 to April, 2018). Further, we have introduced these interventions in the model using structural break analysis. The volatile Ragi price series were modelled and forecasted using popular class of Generalised Autoregressive Conditional Heteroscedastic (GARCH) models and its asymmetric extensions. The results indicated improvement in modelling and forecasting performance of the models after incorporation of the policy interventions. This study has empirically highlighted the positive impact of policies introduced by government of India.

PP69: Strengthening national data ecosystem for evidence-based decision-making in agriculture in the 50x2030 initiative
(Abstract Id: A4-6-050)

Marie Vander Donckt and Roberto Telleria Juarez
ESS, FAO, Rome, Italy
marie.vanderdonckt@fao.org, Roberto.TelleriaJuarez@fao.org

Each year, hundreds of billions of dollars are invested and critical decisions are made in agriculture, often without good evidence to inform those investments and decisions. The scarcity of high-quality, timely agricultural data is a key constraint for low and lower-middle income countries (L/LMICs) to effectively plan, finance, and implement agricultural development strategies as they strive to realize their full potential. The lack of data leads to sub-optimal decisions, causing losses in productivity and agricultural income and, ultimately, more hunger and poverty. The 50x2030 Initiative to 'Close the Agricultural Data Gap' was launched by a group of five donors and multilateral implementers, including UN Food and Agriculture Organization (FAO), the World Bank, and the International Fund for Agricultural Development (IFAD) in September 2018. The Initiative aims to empower and support 50 L/LMICs to build strong national data systems that produce and use high-quality and timely agricultural data through survey programs. Of those 50 countries, approximately 30 will be in Africa. The ultimate goal of the Initiative is evidence-based decision-making to achieve SDG2 – Zero Hunger – among partner countries. The Initiative envisions stronger end-to-end data effectiveness by creating capacity at all stages of the data value chain, including to produce, analyze, interpret, and apply data to decisions in the agricultural sector. To make its solutions last, the Initiative prioritizes two key tenets often overlooked in data-collection projects: 1) ensuring the data are used and 2) building country ownership. A commitment to use agricultural data in policymaking, cost-sharing, and program take-over is a fundamental requirement for countries wishing to join 50x2030. The Initiative also strives to build the capacity and motivation of decision makers to use data.

The inclusion of a data-use objective recognizes that supply side efforts focused on data production alone are unlikely to increase the use of evidence in decision making. The paper discusses the strategy to strengthen national data ecosystem for evidence-based decision-making in agriculture in the 50x2030 Initiative. Especially, FAO and IFAD will present the proposed tools and activities under the Initiative to foster the use of agricultural survey data for planning, decision-making and monitoring purposes in L/LMICs. Early developments and results from firsthand piloting activities implemented in AGRISurvey partner countries and led by FAO will be also presented.

**PP70: Food insecurity in Western Nepal using food insecurity experience scale
(Abstract Id: A5-7-020)**

^aHem Raj Regmi and ^bArun GC

^aEconomic Statistics Division, Central Bureau of Statistics, Kathmandu,
Nepal

^bFood Security, Ministry of Agriculture and Livestock Development,
Kathmandu, Nepal

hregmi1@gmail.com, gcarun8848@gmail.com

Food security has witnessed several definitional and measurement variation on its history of more than half of the century. Measuring food insecurity occupied the central stage of food security studies, mainly, after Millennium Development Goal and its intensity increased sharply after adoption of the Sustainable Development Goals (SDGs). The SDG 2 aimed for ending hunger and Indicator 2.1.2 explicitly pronounced about use of Food Insecurity Experience Scales (FIES) to measure prevalence of moderate or severe food insecurity. Nepal has started estimating food insecurity since 1970s. However, it is the first instance of using FIES in Nepal to calculate food insecurity. A household survey and telephone survey of about 1800 individuals has been carried out in Karnali province using FIES standard questions and other socio-economic variables were also collected. The toolkit developed by FAO using Rasch model was used to estimate moderate and severe food insecurity. To assess the determinants of food insecurity, a multiple regression model was executed using socio-economic variables as explanatory variables. The results showed that around 7 percent population in Karnali province are severely food insecure.

**PP71: Measurement of post-harvest losses in Malawi
(Abstract Id: A6-8-010)**

Emmanuel Jofilisi Mwanaleza

Department of Planning, Ministry of Agriculture, Irrigation and Water Development, Lilongwe,
Malawi

jofilisimwanaleza@yahoo.com

A study on post-harvest losses was conducted in Salima and Lilongwe ADDs to pilot a new methodology for estimating on-farm losses. The study was conducted with technical support from the Global Strategy for Improving Agricultural and Rural Statistics of the Food and Agricultural Organisation of the United Nations. The study principally aimed at strengthening the capacity of Malawi in generating reliable estimates on post-harvest losses. A household questionnaire was developed for quantitative data collection. Data was analysed in Statistical Package for Social Scientists (SPSS). Among the main findings, the study shows that majority of the farm households are involved in rainfed agriculture as their main economic activity. Of paramount importance from the study is the finding that a lot of farm produce are lost during harvesting seconded by threshing. The study also identified timely harvesting and use of chemical as the most effective strategies for preventing post harvest losses. From the pilot it is recommended that baseline data need to be established based on replication of the survey at large-scale consecutively for three years to take into account weather variation factor. The survey need to be integrated into the existing national-wide data collection systems such as the Agricultural Production Estimates Survey to ensure low operational costs and sustainability. It is also recommended that Computer Assisted Personal Interviewing should

be introduced for future exercises to improve on data quality.

**PP72: Data collection on wood products in Cameroon: Accuracy for compilation of
SEEA's forest accounts
(Abstract Id: A12-13-055)**

Salah Markcal Senge
Monitoring and Statistics, Ministry of Forestry and Wildlife, Yaounde, Cameroon
salahmarcel@gmail.com

Cameroon has a significant forest heritage of 22.5 million hectares of which 17.5 million exploitable, with an annual potential production of 9 million m³ per year. The national production is about 2.5 million m³ per year. To collect information related to logging and processed wood, Cameroon has put in place a mechanism for data collection and reporting. This mechanism collects data on species, volumes, type of products, logging or processing companies from the forest to the final destinations. The System of Environmental-Economic Accounting for Agriculture, Forestry and Fisheries (SEEA-AFF) under experimentation in Cameroon provides an excellent platform to review available data based on the existing data collection mechanism on wood forest products, to appreciate the quality of available information and if need be, to take adequate measures for the compilation of forest accounts. This paper aimed at presenting data collection mechanism on wood forest products in Cameroon and the level of accuracy for the compilation of forest accounts.

**PP73: Survival analysis of seed germination using Cox proportional hazard modelling
and other approaches
(Abstract Id: A12-13-053)**

Himadri Ghosh
Statistical Genetics, ICAR-IASRI, New Delhi, India
himadri.ghosh@icar.gov.in

Survival data are a type of time-to-event data that also frequently arises in agricultural research (Fenlon, 2001), for example, when measuring flowering times or germination times. Since these traits are not measured continuously but during several assessment times, we never know when exactly flowering and germination took place. What we do know instead is that these events took place between the two subsequent assessment times (interval-censoring). Traditionally, it is assumed that germination times within a population follow some continuous distribution, usually skewed to the right. Therefore, the time course in the proportion of germinated seeds can be described using some CDF, such as the log-normal or log-logistic functions (Berry, Cawood, & Flood, 1988). However, nonlinear regression assumes model errors (deviations of observed proportions from the fitted curve) to be normally distributed, homoscedastic and independent—which assumption often appears to be violated in germination assays (Hay, et al., 2014). Therefore, instead of ignoring the problem of censoring, we can use censored data methods, which were developed to deal with censoring. In so doing, we would consider that each seed in the lot can be assigned a germination time with likelihood in the form of probability of an interval yielding multinomial likelihood. Since temperature and moisture are the most important factor in seed germination, in this regard, three "cardinal temperatures" generally characterize germination responses to temperature: the minimum, optimum and maximum. The minimum (or base, T_b) and maximum (or ceiling, T_c) are the temperatures below or above which germination will not occur, while the optimum (T_o) is the temperature at which germination is most rapid. Till now there is no uniform definition of optimal temperature T_o in the light of its accepted definition as the soil temperature at which the highest germination percentage is achieved by a seed population in the shortest possible period of time (Mayer &

Poljakoff-Mayber,1975). While adopting this definition, one may find it difficult to evaluate T_o if the highest germination is observed to be g_1 in shortest time compared to the situation where highest germination is observed to be g_2 much larger than g_1 . To circumvent that, alternate definition of T_o is considered where the time to germination is considered by keeping specific germination percentage (g) at the outset. In the present paper, attempt has been made to develop methodology to obtain optimal temperature and moisture by Cox proportional hazard modelling needed to minimize seed germination time (timely seed germination is important in Agriculture for growing seedling in adequate environment which is followed by vegetation stage and then flowering) for fixed lower tail germination percentage, as farmers are provided seed lot customarily with various percentage germination certificate from seed companies. Attempt has also been made to develop methodology to obtain optimal temperature and moisture maximizing the chance of seed germination under the condition of fixed germination time. This is because farmer may wait for fixed time of germination only.

PP74: Combining Stochastic and Machine Learning Approach for Modelling Indian Rainfall
(Abstract Id: A8-0-001)

Ranjit Kumar Paul, A K Paul, L M Bhar
ICAR- IASRI, New Delhi, India
ranjit.paul@icar.gov.in, amrit.paul@icar.gov.in, lm.bhar@icar.gov.in

Agriculture in India is highly sensitive to climatic variables particularly to rainfall and temperature, therefore any change in rainfall and temperature will influence crop yields. An understanding of the spatial and temporal distribution and changing patterns in climatic variables is important for planning and management of natural resources. Time series analysis of climate data can be a very valuable tool to investigate its variability pattern and, maybe, even to predict short and long-term changes in the time series. In this study, the sub-divisional rainfall data of India during the period 1871 to 2016 has been investigated. One of the widely used powerful nonparametric techniques namely wavelet analysis was used to decompose and de-noise the series into time–frequency component in order to study the local as well as global variation over different scales and time epochs. On the decomposed series, Autoregressive Integrated Moving Average (ARIMA) as well as Artificial Neural Network (ANN) model is applied and by means of inverse wavelet transform, the prediction of rainfall for different sub-divisions have been obtained. To this end, empirical comparison was carried out toward forecast performance of the approaches namely Wavelet-ANN, Wavelet-ARIMA and ARIMA. It is reported that Wavelet-ANN and Wavelet-ARIMA approach out performs the usual ARIMA model for forecasting of rainfall for the data under consideration.

PP75: Confronting the global water crisis through research
(Abstract Id: A8-10-035)

Sachin Singh and Sasmita Tripathy
Agronomy, Indian Agricultural Research Institute, New Delhi, India
sachin.singh12524@gmail.com, sasmita1995@gmail.com

Human global population growth – 83 million more people each year – leads to concomitant growth in water demand by agriculture, consumers and industry, which in turn leads to water resources crises throughout the world. The best example is the growing demand for agricultural products – nearly 70% of worldwide water use is for irrigation. Expanding population and consumerism have led to increasing demand for food and consumer goods, which in turn fuels the demand for water. For

example, it takes 1,857 gallons of water to produce a pound of beef, 2,900 gallons for a pair of cotton blue jeans, and 766 gallons to produce one T-shirt. Growing industrialization also increases water demand. Approximately 22% of fresh water use is industrial, including hydroelectric plants, water for cooling in data centers, and in processes in manufacturing and refineries. Only 8% is used for household purposes – cooking, bathing and washing. However, water use varies widely. Average water use per person per day is 575 liters per day in the United States and 4 liters per day in Mozambique. Human uses of water are dramatically outstripping the resupply of water sources. Over pumping of groundwater, polluted runoff and erosion are problems facing agriculture and cities throughout the world. Unsustainable groundwater use occurs throughout the world, in high- and low-income nations. In Europe, 60% of cities over 100,000 people are using groundwater faster than it can be replenished. Critical aquifers are being drained: Mexico City, Bangkok, Beijing, Shanghai, Madras and Manila have all seen their drinking water aquifers drop between 10 to 50 meters. Within 15 years, 1.8 billion people will live in regions with severe water scarcity. A well-known problem is that the warming of the planet has led to shrinking icecaps and glaciers – the planet's principal reservoir of fresh water – whose fresh water supply is draining away into the salty sea. Water resource crises also threaten national security when water scarcity creates instability by thwarting economic development, threatening public health and heightening regional conflicts. Yet, many of our planet's water resources problems can be resolved. A 2006 United Nations report, entitled "Water, A shared responsibility," states this fact emphatically: "There is enough water for everyone." Such conclusions underscore the critical importance of water resources research and explain its rapid global expanse. Countries are increasingly turning to water resources research to solve local, regional and global water problems. With this analysis we examine the literature on water resources over five years up to 2008. Water resources research is expanding worldwide as countries and funding agencies turn to scientists to help solve problems of dwindling fresh water supply and oceanic changes that impact every continent. Many countries which ten years ago undertook very little water resources research, are today ramping up their research capacity. These often are countries where rapid industrialization and population growth has created unsustainable water resources practices. Since the year 2000, the number of published research articles worldwide on water resources has grown at a steady rate of 30% a year.

PP76: Precision agriculture and potential market in India
(Abstract Id: A7-9-032)

Sasmita Tripathy and Sachin Singh
Division of Agronomy, ICAR-IARI, New Delhi, India
sasmita1995@gmail.com, sachin.singh12524@gmail.com

At the global market, Precision Agriculture (PA) solutions abound at different levels of the value chain. PA market comprises of technologies such as guidance systems, remote sensing, and Variable Rate Technologies (VRT). Guidance systems are divided into GPS (Global Positioning Systems) and GIS (Global Information Systems). Remote sensing is segmented into hand-held and satellite based sensing. VRT is segmented into variable rate fertilizer, variable rate pesticide, and variable rate seeding. The lack of awareness and absence of dedicated education of PA among the farming sector is by far the major pain point for the market. Other issues include lack of standards and data management revolving around the PA industry. When it comes to India, issues of agricultural sector range from low per capita productivity, absence of skilled labor, high cost of cultivation to insufficient soil management. With close to 200 million farmers in India, the need of the hour is to reach viable and cost effective solutions to the Indian market. A study was undertaken to understand the impact of precision farming on resource-poor regions and underprivileged farmers. Specifically, the study has looked into productivity, income, employment, and adoption behavior of technology in agriculture. The study, conducted in the Dharmapuri district in Tamil Nadu, India, has collected data on precision and non-precision farming through the interview schedule during the year 2007. The study has revealed that adoption of precision farming has led to 80 per cent increase in yield in tomato and 34 per cent in eggplant production. Increase in gross margin has been found as 165 and 67 per

cent, respectively in tomato and eggplant farming. The contribution of technology for higher yield in precision farming has been 33.71 per cent and 20.48 per cent, respectively in tomato and eggplant production. The elasticity of 0.39 for the adoption in tomato and 0.28 in eggplant has indicated that as the probability of adoption increases by 10 per cent, net return increases by 39 per cent and 28 per cent in tomato and eggplant cultivation. Conceptualizing Information and Communication Technologies (ICT) platforms have to be done after consulting the users. Agricultural practices are crop specific and region specific. ICT platforms have to be specifically customized for user needs. Development of ICT platforms have to be done in a phased manner so that the project grows in an evolutionary manner. Starting the project in a pilot phase and then validating and expanding it, is the best way for making sure that a project concept works in real life. The crucial aspect of ICT in rural areas is that the contact person should develop a working relationship and trust at the grass root level. Relationships have to be developed with the users and platform holders. BIS Research estimates the global market size for precision agriculture to grow over \$6.34 billion by 2022 at an estimated CAGR of 13.09% from 2015 to 2022. The trends suggest that with U.S. at the forefront, North America will continue with its dominance during the forecast years.

PP77: Determinants of household consumption of pulses in India - A multi-level model approach
(Abstract Id: A5-7-041)

^aAnjaly Teresa John, ^aSanchit Makkar, ^bTinku Thomas, ^aSumedha Minocha, ^aSumathi Swaminathan, and ^cAnura V. Kurpad

^aDivision of Nutrition, St.John's Research Institute, Bangalore, India.

^bDepartment of Biostatistics, St.John's Medical College, Bangalore, India

^cDepartment of Physiology, St.John's Medical College, Bangalore, India
 anjaly.tj@sjri.res.in, sanchit.m@sjri.res.in, tinku.sarah@sjri.res.in,
 sumedhaminocha@gmail.com, sumathi@sjri.res.in, a.kurpad@sjri.res.in

Pulses can play an important role in achieving nutritional security in India through the provision of quality protein. Before promoting pulses, it is imperative to understand the patterns of consumption and production of pulses across districts and the drivers of consumption. In this study we examine the household and district-level factors of availability, accessibility and affordability that affect household intake of pulses. Data on pulse consumption was obtained from the 68th round of the Consumer Expenditure Survey National Sample Survey Organization (2011-12) and on district annual pulse production (2011-12) from Area and Production Statistics, Ministry of Agriculture and Family Welfare. Multi-level linear modelling of household pulse consumption was performed with district-level production of pulses, household and district-level covariates. Average availability, i.e. annual production surplus in a district is positively and significantly associated with household pulse intake. In terms of affordability, a 10-rupee decline in a district's mean pulse price can improve the average annual household intake by 1.607 kg, while a 1000-rupee increase in a household's monthly expenditure improves it by 1.87 kg. Accessibility to markets, (distance of the district to the nearest tier-I or II city) was significantly negatively associated. Household-level characteristics like maximum education attainment by a woman in the household and the household's engagement in pulse production were positively and significantly associated with household pulse intake. These effects were significant even after adjusting for mean per capita expenditure of the district. Affordability, market accessibility and regional availability of pulses are vital aspects for a household's pulse intake, which is a cheap source of protein. A whole host of household and regional-level characteristics are at play and policies to promote nutrition security and improve pulse consumption cannot prioritize one over another.

PP78: Development of land resources inventory for a watershed in Bundelkhand region, India
(Abstract Id: A7-9-033)

^aTejasi Shah, ^bJyoti P Patil and ^bV C Goyal

^aDepartment of Energy and Environment, TERI School of Advanced Studies, Delhi, India

^bResearch Management & Outreach Division, National Institute of Hydrology, Roorkee, India

tejasishah2@gmail.com, jyotipp2003@gmail.com, vcg.nihr@gov.in

Land Resources Inventory (LRI) is a compilation and description of the existing natural resources data, and indicates potentials and constraints for developing a site-specific resource conservation plan. A study was carried out for Kathan river watershed in Madhya Pradesh, Bundelkhand Region, India to characterize the natural resources like soil, water, and land. The study involved assessment of the suitability of land for major crops and delineation of homogenous areas in form of land management units based on soil-site characteristics. The analysis included interpretation of climatic data, soil data, assessment of crop water requirements, number of irrigations, depth of irrigation, and establishment of watershed level digital land resources database in a GIS framework. The suitability and limitations of land for selected kharif and rabi crops were presented in the form of thematic layers. Further, land management units of the watershed were suggested for the identified crops covering aspects such as crop rotation, intercropping, and suitable interventions for improving the land productivity. The study concluded that LRI provides detailed analysis of natural resources, which is important for watershed planning process. Further, LRI-based natural resource conservation plan provides a scientific tool to educate people and stakeholders on the watershed conditions and to identify specific actions needed to improve water management in the study area.

PP79: Statistical approach for identification of hub genes in gene co-expression networks using RNA-seq data: An application to salinity stress in rice
(Abstract Id: A12-13-054)

^aSamarendra Das, ^bTed Kalbfleisch, and ^aShesh N Rai

^aBioinformatics and Biostatistics, University of Louisville, Louisville, United States

^bBiochemistry and Molecular Genetics, University of Louisville, Louisville, USA
samarendra.das@louisville.edu, ted.kalbfleisch@louisville.edu, shesh.raai@louisville.edu

Merging of network theory with RNA-seq data analysis leads to the discipline of network biology and Gene Co-expression Network analysis is one such key approach. Hub genes in such networks are important for keeping network structure intact and maintaining key functional roles. The approaches used to detect them are mostly empirical so far. Hence, this study proposes a statistical approach for hub gene detection using high throughput RNA-seq data, where hubs are identified based on statistical significance values computed through a non-parametric statistical testing coupled with bootstrap procedure. Besides, a differential hub gene analysis approach has also been developed to group the hubs into various groups based on statistical strength of gene connections. The comparative performance analysis on real microarray and RNA-seq data sets showed that the proposed approach outperformed existing ones in terms of the scale free property of real networks. Moreover, this approach was used to understand the salinity stress response mechanism in rice and to identify hubs and salinity induced gene networks. These reported hub genes can be used as potential targets for salinity stress engineering. Also, dhgaSeq R package has been developed for the users.

PP80: Sustaining agriculture development under influence of technology – Impact

assessment on the growth rate of GDP from agriculture in Bihar
(Abstract Id: A5-7-005)

^aJitendra Kumar Sinha and ^bAnurodh Kumar Sinha
^aDirectorate of Economics and Statistics, Patna, Bihar, India
^bConsultant, Taru Leading Edge, New Delhi, India
jksinha2007@rediffmail.com, anurodhsinha@gmail.com

The 'End of Hunger' one of the leading Sustaining Development Goals supported by the United Nations in 2015 focuses on promoting sustaining agriculture. It aims to ensure full implementation of sustainable food production system and resilient practices to double the agricultural productivity and income of small-scale food producers by 2030. Applications of technology have dramatically increased food production in real terms over the last six decades but its indiscriminate or inappropriate use have also clearly produced negative consequences to the ecosystem and threaten the long- term viability of the enterprises and leads to the central issue of sustainability, i.e., stability under a given set of environmental and economic circumstances. Thus, orientation of future technology need to greatly influence the stability and productivity of agriculture through the environmental modeling combined with risk management algorithms. Bihar is one of the prominent states of India, currently lying at the lower rung of the industrial index and highly dependent on agriculture, the riskiest business- with substantial employment and income arising from subsistence farming. Hence, the goal of the agricultural production system is to maximize income of land owning and landless rural populace to improve their livelihoods through effective risk management strategies to cover potential losses and enhance income. It is thus, important to investigate how the range of agricultural technologies like mechanization, chemical technology, management practices and policies relating to cropping, as well as other agricultural infrastructures, could improve value addition to the gross domestic product besides the common factors of production like capital stock, labour force and land area. The main issues investigated in this study are – (i) how are agricultural technologies linked to the agricultural production growth; (ii) what association of agricultural technologies should be deployed for sustaining the growth of the agricultural gross domestic production in Bihar; and (iii) what are the projected value of the agricultural productivity and income of small-scale food producers by 2030. The study depends on the Cobb- Douglas production function to determine the influence of agricultural technologies on the growth of agricultural value-added over the period 1995-2018. The dataset supporting analysis comprises of one endogeneous variable (Agricultural value-added) and nine exogeneous variables (Net Capital Stock; Number of machines used; Energy used to power irrigation; Number of workers in agriculture sector; Area of arable land and permanent crops; Area on planted and naturally regenerated forests; Area equipped for irrigation; Amount of chemical fertilizers consumed). The data were examined for stationary of time trend through the Augmented Dickey-Fuller Test and processed through suitably developed R- Programming. Then , an analysis is made of the response of agricultural value-added growth over time following technological innovations or shocks and project them up to 2030.

PP81: Agri and food startup ecosystem in India
(Abstract Id: A5-7-039)

^aSrinivas Kondapi and ^bVikram Singh
^aResearch Systems Management, ICAR-NAARM, Hyderabad, India
^bIntellectual Property and Technology Management, ICAR Headquarter, New Delhi, India
ksrinivasnaarm@gmail.com, kmnmvs@gmail.com

Government of India through different policies and schemes like National Intellectual Property Rights

(IPR) policy, Make in India, Skill India, Start Up India, Smart Cities, Digital India policies trying to build a strong ecosystem for nurturing innovations and Start-ups/entrepreneurship in the country. The country is predominantly agrarian as its majority workforce is engaged in it. This sector has a huge potential for promoting innovations as it has rich resources of traditional indigenous knowledge, biodiversity and human capital. The country is gradually started shifting from 'a producer-driven to demand driven and market-led' agricultural research and development (R&D) system. ICAR had established 24 Agri- business Incubation (ABI) Centers to nurture early stage innovative startups and entrepreneurs Ministry of Agriculture's Rural ABI programme is also gaining momentum. In 2018 agri-tech startups raised around \$65.6 million in 2018, and food sector startups around \$516. The experience of two cases, indicates that the food and agriculture sector has been thronged by the streams of educated youth, fired by the ideas, passion and innovations. These entrepreneurs and startups are providing missing links in the agri-value chain and delivering efficient products, technologies and services to the farmers on one hand and the consumers on the other hand. Through two cases it can be inferred that there are better opportunities for nurturing and building innovative enabling platforms for agri-business and agri-entrepreneurship in the country.

PP82: Employment generation in agriculture through innovation management and agri-incubation in India
(Abstract Id: A5-7-040)

Vikram Singh and Shiv Datt

Intellectual Property and Technology Management, ICAR Headquarter, New Delhi, India
kmmms@gmail.com, shivdatt1@gmail.com

India is a young country, where 35% population is coming under the age group of 15 to 25, which is increasing year after year. To engage this population in country's development and to make their future bright is the major task for policy makers and political leadership. India is the country, where agriculture is the main stay for employment, which is having enormous opportunities for business development. In view of the above fact government of India started a flagship programme with the name of Start Up India in 2016 with a total budget of INR 10,000 crore aims at building a strong ecosystem for nurturing innovations and Start-ups/entrepreneurship in the country. To achieve the goals of this initiative different public and private organizations started supporting the start-up/entrepreneurs through their innovations and incubation facilities. National Agricultural Research and Education Systems in India is well equipped with infrastructure and innovations, which becomes the path for filling up the gaps of unemployment. In an analysis of 12 years' innovation dissemination at Indian Council of Agricultural Research (ICAR) it was found that 651 technologies/process transferred to 1081 public and private organizations by signing 1847 licensing agreements. These innovations were supported by 25 Agri-business Incubation (ABI) Centres keeping in view the spectrum of technologies, available infrastructure and the core competency of the institutes. In the year 2018-19 these ABI centres facilitated 377 such stakeholders for their business incubation activities. These efforts, motivated 161 entrepreneurs/ start-ups to initiate their own business.

PP83: Development of Mobile app for Anthropometrics in Agriculture
(Abstract Id: A5-0-001)

Sangeeta Ahuja

ICAR-IASRI, New Delhi, India
reach2san@yahoo.com

Anthropometric body dimensions play a significant role in human-machine interaction. The overall working efficiency of human-machine environment and resultant discomfort has severe impact while using farm tools and machinery in agricultural fields. A large proportion of the workforce in the world is involved in agriculture or related occupations. In India, about 300 million workers are associated with farm work constituting one fifth of the world's agricultural work force. An estimated 77.6% of all incidents were due to farm machinery, 11.8% were due to hand tools, and the remaining 10.6% were due to other factors. It has been reviewed that hand injury statistics from literature and inferred that hand tools cause 9 of all reported disabling injuries, and 75% are because of manual tools. Hand tool constitutes significant number (58%) in farm injuries, involving a very high number of farm workers (65%). The anthropometric data of agricultural workers in order to obtain information of the body dimensions, which can be used in design of farm equipments or to improve farm tools ergonomically. Forty five different structural body dimensions and four strength parameters are identified and the measurement was conducted. The data to be measure statistically analyzed for mean, standard deviation and percentile values which are used in design. Measured and calculated anthropometric data of agricultural workers could be useful in design and modification of farm implements which would reduce drudgery and discomfortness of farm worker and enhance the efficiency. This is the tool in reference to descriptors associated with comfort, safety and functionality. This application will be useful for anthropometric assessment tools and the modification of hand tools, personal protective equipment, workstations and interface systems imported into agricultural workers to reduce human error and improve public health. The inclusion of anthropometric data helps ensure that devices or machines are safe, user-friendly and highly productive and efficient. The app is developed using Android Studio 3.3.2 and the minimum requirement for the app is a device running on API 16: Android 4.1 (Jelly Bean). The application is based on three-tier architecture of the software development. The client-side layer is the android application itself which is implemented by the JAVA Programming language and XML. The server application layer contains core classes like database connection, the connection between other layers. The database layer consists of the data of anthropometric dimensions of agricultural workers related to the designing ergonomically sound farm machineries and equipments. The mobile app has been tested for the various agricultural activities in field and provides very promising results. This android app would be of great use to the farmers/ user for reducing drudgery during farm activity. The user can also utilize information about all anthropometric measurements of agricultural workers in one go. In nutshell, the mobile app for anthropometric would be beneficial for all agricultural workers.

**PP84: Chain Type Product Estimator for Two Stage Sampling Designs
(Abstract Id: A10-11-048)**

Ronit Jaiswal and U.C. Sud
ICAR-IASRI, New Delhi, India
ronitjaiswal2912@gmail.com, dr.ucsud@gmail.com

Many a times, inverse relation exists between the study and the auxiliary variables. In situations where negative correlation exists between the study and the auxiliary variable a product estimator is used for the estimation of population mean. Considering only two auxiliary variables here the situation is assumed that the population mean of one auxiliary variable, say X, highly correlated with the study variable, say Y, is not known before the start of a survey but the population mean of another auxiliary variable, say Z, which is closely related to X and is loosely correlated to Y, is readily available. In such case, chaining of estimators is required in order to use the acquired information on various auxiliary variables and double-sampling design is found to be suitable for gathering information. So under this research two different chain type product estimators are developed under two-stage sampling design using two auxiliary variables. Two control estimators are also considered i.e. the product estimator and the simple linear estimator under two-stage sampling design. The

performances of the four estimators are compared in terms of the criteria of relative bias and relative mean square error through an empirical study using simulated data. A suitable cost function is also considered. Optimum values of sample sizes are determined by minimizing the cost for a fixed value of mean square error. The performances of the four estimators are considered using the optimum values of sample size with the help of an empirical study.

PP85: Randomized Designs for Higher order Mating Experiments including Specific Combining Abilities
(Abstract Id: A12-13-056)

^aMohd Harun, ^aCini Varghese, ^aSeema Jaggi and ^bEldho Varghese

^aICAR-IASRI, New Delhi, India

^bICAR-Central Marine Fisheries Research Institute, Kochi, India

harun.agribhu@gmail.com, cini.varghese@icar.gov.in, seema.jaggi@icar.gov.in and
eldho.varghese@icar.gov.in

Higher order mating experiments, in particular, tetra-allele cross experiments have been considered and, for the data collected via these experiments, a model that incorporates both general combining ability and specific combining ability effects is postulated. Under such a model, conditions of orthogonality have been derived for a block design such that the contrasts pertaining to the general combining ability effects and specific combining ability effects are estimated free from each other, after eliminating the other nuisance factors. Conditions for universal optimality of block design for tetra-allele cross experiments have been derived and various related results regarding the existence of universal optimal designs have been deduced.

PP86: Empirical mode decomposition based neural network for agricultural price forecasting
(Abstract Id: A3-5-036)

Kapil Choudhary, Girish K. JHA, Rajeev R. Kumar and Ronit Jaiswal

ICAR-IASRI, New Delhi, India

choudharykapil832@gmail.com, girish.stat@gmail.com, rajeev.kumar4@icar.gov.in and
ronitjaiswal2912@gmail.com

Agricultural price forecasting is one of the challenging areas of time series analysis due to inherently noisy, nonstationary and nonlinear characteristics of a time series data. In this study, an ensemble empirical mode decomposition (EEMD) based neural network model is proposed for agricultural price forecasting. For this purpose, the original price series was first decomposed into several independent intrinsic mode functions (IMFs) and one residue component. In this paper, monthly price data of soybean oil from international market decomposed into seven independent intrinsic modes and one residue with different frequencies, indicating some interesting features of price volatility. Then a time-delay neural network (TDNN) with single hidden layer was constructed to forecast these IMFs and residue component individually. Finally, the prediction results of all IMFs including residue are aggregated to formulate an ensemble output for the original price series. Empirical results demonstrated that the proposed EEMD-TDNN model outperforms the TDNN model in terms of root mean square error and directional prediction statistics, mainly due to nonlinear and nonstationary characteristics of series.

**PP87: Methodology for Bio-equivalence Assessment of Veterinary Medicinal Products
(Abstract Id: A12-13-057)**

Sumeet Saurav, Cini Varghese and Seema Jaggi
ICAR-IASRI, New Delhi, India
cini.varghese@icar.gov.in, seema.jaggi@icar.gov.in and sumeet4927@gmail.com

In veterinary medicinal trials, formulations are to be applied to the animals sequentially over time due to scarcity of homogeneous and healthy animals for experimentation, leading to carryover effects. Further in such trials, many a time it may be required to compare some new (test) formulations to a previously well established (reference) formulation. Bio-equivalence trials, using designs balanced for carryover effects, are advantageous for such situations. As experimental units are used sequentially over periods, there is a possibility that a systematic effect, or trend, influences the observations in addition to the experimental unit effect, formulation effect and carryover effect. Condition have been derived for designs for bio-equivalence trials balanced for carryover effects to be trend-free and a method of constructing a class of such designs has also been developed. When trend effects are suspected, trend free designs are to be selected for experimentation and data need to be analyzed accordingly.

**PP88: Network designs in agroforestry systems for sustainable livelihood
(Abstract Id: A12-13-058)**

Peter T. Birteeb, Cini Varghese, Seema Jaggi, Mohd Harun and Eldho Varghese
ICAR-IASRI, NEW DELHI, INDIA
bpetert2000@gmail.com, cini.varghese@icar.gov.in, seema.jaggi@icar.gov.in,
harun.agribhu@gmail.com, eldho.varghese@icar.gov.in

The use of an appropriate design is a very important aspect of agroforestry experimentation. Since trees may interact spatially, plots in agroforestry could be connected through network of trees which would create non-directional adjacency effects on a plot. Hence, there is a need to take the direct “effect of trees” and “tree network effects” into account when designing an agroforestry experiment. Tree network effect refers to the influence a tree exerts on the surrounding plots as a result of adjacency of the plots. In this paper, a class of network designs incorporating effects of trees from adjacent plots has been studied. Method of constructing these network designs with non-directional tree effects has been developed. The characterization properties of the designs have also been studied and the designs are found to be variance balanced for the estimation of direct tree and tree network effects.

**PP89: Price Forecasting using EMD-SVR hybrid model: An Ensemble learning
Paradigm
(Abstract Id: A4-6-070)**

Pankaj Das, Girish Kumar Jha, Achal Lama and Murari Kumar
ICAR- IASRI, New Delhi, India
pankaj.iasri@gmail.com, girish.stat@gmail.com, chlhm6@gmail.com, murari.iasri@gmail.com

Price forecasting of agricultural products is a vital market-information for farming communities. The price instability and uncertainty pose a significant challenge to decision-makers in coming up with

proper production and marketing plans to minimize risk. Price series cannot be modeled and predicted accurately by traditional econometric models owing to its nonlinearity and nonstationary behaviour. In the present study, an attempt has been made to model and predict price series using Empirical Mode Decomposition (EMD) based Support Vector Regression (SVR) model. The EMD-SVR model is an ensemble method containing EMD and SVR techniques. EMD decomposes the original nonlinear and nonstationary dataset into a finite and small number of sub-signals. Then each sub-signal was modeled and forecasted by the SVR method. Finally, all the forecasted values of sub-signal were aggregated to make the final ensemble forecast. The effectiveness and predictability of the proposed methodology was verified using Chilli wholesale price index (WPI) dataset as sample. Further EMD based Artificial Neural Network (ANN) model has been fitted to check the performance of the proposed EMD-SVR model. The results indicated that the performance of the proposed model was substantially superior as compared to the generic SVR and EMD-ANN model.

PP90: Statistical Techniques for Discrimination of Fruit Crops using Hyperspectral Satellite Data
(Abstract Id: A1-1-079)

^aNobin Chandra Paul, ^aPrachi Misra Sahoo, ^aR. N. Sahoo, ^bBappa Das, ^aAnkur Biswas, ^cGopal Krishna, ^aAnil Rai, ^aTauqueer Ahmad

^aICAR-IASRI New Delhi, India, ^bICAR-CCARI, Goa, India, ^cAmity University, Noida, India
ncp537@gmail.com, prachiiiasri@gmail.com, rnsahooiari@gmail.com, bappa.iari.1989@gmail.com, ankur.bckv@gmail.com, rsgis.gkr@gmail.com, anilrai64@gmail.com, tauqueer.khan01@gmail.com

In case of field crops, temporal multispectral data can be helpful in capturing crop phenology, hence may discriminate field crops whereas horticultural crops being perennial in nature, not having distinct phenology, it is difficult to discriminate horticultural crops using temporal multispectral data. Major limitation of multispectral data is lesser number of bands and mixed pixels which may not be able to discriminate fruit crops but the hyperspectral data has the advantage of having relatively large number of narrow, contiguous bands which lead to continuous spectral reflectance curve, making intricate details visible in the spectrum. This study has been undertaken to investigate statistical techniques for discrimination of fruit crops of existing orchards using hyperspectral satellite data. The spectral reflectance of leaves of various fruits was collected directly from the field using Spectroradiometer and after collecting spectral reflectance, discrimination of fruit crops was done using the four tier hierarchical statistical techniques which includes one way Analysis of Variance (ANOVA), Classification and Regression Tree (CART), Jaffries-Matusita (J-M) Distance and Linear Discriminant Analysis (LDA). The results of one way ANOVA showed that spectral reflectance were statistically significant at most of the wavebands. i.e bands which can effectively discriminate the fruit crops and remaining bands were non significant. The non significant bands were discarded. CART technique further reduced the number of significant wavebands selected by one way ANOVA analysis to fewer spectral bands which can optimally discriminate the fruit crops. J-M distance analysis was performed on the optimum wavebands selected from CART analysis to check whether these wavebands could discriminate different fruit crop pairs. Discriminative power of the wavelengths was further assessed on the basis of overall accuracy using LDA. The study has been conducted on two areas which include Sabour in Bihar and ICAR-Indian Agricultural Research Institute, New Delhi. The study reveals the limitation of multispectral data in fruit crops discrimination. As the number of bands gets reduced the discriminative power of the data set also gets down. This study concludes that hyperspectral data has more discriminative power than the multispectral data for discriminating fruit crops. The proposed four tier statistical method can be utilized efficiently for discrimination of fruit crop orchards.

PP91: INPUT -RESPONSE RELATIONSHIP IN THE PRESENCE OF SPATIAL

EFFECTS
(Abstract Id: A12-13-059)

Ankita Verma
ICAR-IASRI, New Delhi, India,
ankiverma95@gmail.com

There may be experimental situations wherein the response from a unit may be affected by other units spatially belonging to the same cluster or group or block. This situation arises in a wide array of experiments in different areas such as medicine, agriculture, education, marketing. Understanding the structure of these effects helps in minimizing the bias in the treatment comparisons to a great extent so as to make more precise inference. It is thus important to include the spatial effects in the model to have the proper specification and obtain plans in the presence of spatial effects that are ordered over space. In many investigations, the aim is to determine and quantify the relationship between one or more measurable response variable(s) and a group of input factors presumed to affect the response(s) and to further find the setting of the experimental factors that produces the best set of values of the response(s). Response surface methodology is used for this purpose. In many experiments, it may not be necessary that all the factors under study have equal number of levels. Here, the methodology for studying input-response relationship for factors at different levels in the presence of spatial neighbour effects has been developed, specifically for the situation when there are n factors at two levels each and one factor at three levels i.e. $2n \times 3$. The model considered is a second order model without interaction terms. Conditions have been derived for the near orthogonal estimation of coefficients of response model. Further, conditions for constancy of variance of estimated response (termed as rotatability) under these models have also been obtained. A method of obtaining plans for fitting second order response model in the presence of spatial effects in case of $2n \times 3$ has been developed. The designs developed ensure the constancy of the estimated variance. SAS macro has been developed to generate the plans, compute the variance of parameter estimates and estimated response under second order model incorporating spatial effects. This will provide easy accessibility and quick reference to the experimenters for their research.

PP92: Wavelet decomposition and ARFIMA model for modelling wheat price in Haryana, India
(Abstract Id: A4-6-071)

Sandipan Sarkar, Ranjit Kumar Paul and L M Bhar,
ICAR-IASRI, New Delhi, India
saandeepan.saarkaar@gmail.com, ranjitstat@gmail.com, lmbhar@iasri.res.in

Agricultural time-series data concerning production, prices, export and import of several agricultural commodities is published by Indian government along with other private agricultural sectors every year. The analysis of these factors is necessary to formulate and apply several policies regarding food acquisition and its distribution, quality and quantity of import and export products, pricing structure, MSP of agricultural commodities etc. Box – Jenkins's Autoregressive integrated moving average (ARIMA) model is broadly utilized in the field of time-series. In general, it is assumed by most of the researchers that the data points of distant time lags do not depend on each other, i.e. absence of long memory process. But in agriculture, market price data exhibits that the observation are dependent on distant past. This is the possible indication of long memory process or long range dependency in the mean model. Autoregressive fractionally integrated moving average (ARFIMA) model is generally used to portray the characteristic features of the long memory time series as well as for the forecasting purposes. In this study powerful nonparametric wavelet decomposition is used to extract the actual signal from noisy data followed by application of suitable ARIMA and AFRIMA model on the

decomposed series. The final prediction of the price series is obtained by means of inverse wavelet transform. Daily wholesale price of wheat in Rewari market of Haryana is used for the demonstration of the approaches. To this end, the prediction accuracy of two approaches is compared in terms of MAPE and RMSE values. The study reveals that forecasting performance of wavelet approach is more efficient than the usual ARFIMA model in terms of lower MAPE and RMSE values.

**PP93: Estimation of finite population total using geo-referenced data
(Abstract Id: A1-1-080)**

Samir Barman, Hukum Chandra and Kaustav Aditya
samir.iasri15@gmail.com, hchandra12@gmail.com, kaustav.aditya@icar.gov.in

In recent years, the model-based approach of survey estimation has received considerable attention of survey statistician. The popularity of model-based method is due to two mutually reinforcing trends in modern sample surveys. First, the need to provide sample survey solutions for inferential problems that lies outside the domain of design-based theory, particularly situations where standard probability based sampling methods are not possible. Second, the need for methods of survey inference that can efficiently integrate the increasing volume and complexity of data sources provided by modern information technology. In model based approach the population is assumed to follow a model. In general, a linear model is assumed with underlying assumption that the population units are independent. In many surveys (for example, agriculture, forestry, environmental, ecological surveys), data are spatially correlated and independence assumption is questionable. As a result, the existing estimators for population total (or mean) based on standard survey estimation method can be biased and less efficient. Use of spatial information in survey estimation is expected to provide a better estimation of population parameters. We developed estimator for finite population total which incorporates spatial information. The proposed estimator for finite population total was also evaluated through simulation studies using synthetic population generated under the assumed models. The empirical results show that the developed estimator has smaller bias and better efficiency as compared to existing estimators.

**PP94: Dexterous Estimation of Population Mean in Survey Sampling under Non-Response Error
(Abstract Id: A1-1-081)**

Dr. Dharmendra Kumar Yadav,
Government of Uttar Pradesh, Lucknow, India
dkumar.yadava@gmail.com

In this scripture, we ponder the problem of efficient estimation of population mean of study variable utilizing information on highly correlated auxiliary variables under the presence of non-response on either of the variables. For this purpose, we suggest, an improved estimator under three different situations of non-response. Under the first situation, estimation of population mean is done with the problem of non-response on both the study and the auxiliary variables with the additional condition that the population means of the auxiliary variables are known. The second situation is to estimate the population mean of primary variable when the problem of non-response is only on the primary variable but the population means of the auxiliary variables are known while under the third situation estimation is performed with the problem of non-response on both the study and the auxiliary variables but population mean of one of the auxiliary variables is unknown. We study the sampling properties of the suggested estimator under above three different situations of non-response. We compare the proposed estimator with the competing estimators of the population mean, under three different situations of non-response. The efficiency conditions are obtained for all three situations. A

numerical study is also carried out to verify the efficiency conditions.

PP95: Statistical Designs for Fitting Response Surfaces Incorporating Neighbour Effects
(Abstract Id: A10-11-049)

Jitendra Kumar, Seema Jaggi, Eldho Varghese, Arpan Bhowmik and Cini Varghese
ICAR-IASRI, New Delhi, India
jitendra.iasri763@gmail.com, seema.jaggi@icar.gov.in, eldhoiasri@gmail.com,
arpan.stat@gmail.com, cini.varghese@icar.gov.in

Response Surface Methodology (RSM) approximates the relationship between one or more response variables and a set of experimental variables or factors. In RSM, it is generally assumed that the observations are independent and there is no effect of neighbouring units. But under the situation when the units are placed linearly with no gaps there is high possibility of overlapping or neighbour effects from the adjacent units. So including these effects into the model is of great importance in deciding the precision of the experiment. Further, availability of resources and size of the experiment is important factor in conducting an experiment. As the size increases, cost involved in conducting the experiment increases, thereby decreasing the precision of the experiment. In this study, response surface designs incorporating neighbour effects have been considered. Method of constructing First Order Rotatable Designs with Differential Neighbour Effects (FORDDNE) have been developed in smaller number of runs. The designs developed ensure the constancy of the prediction variance

PP96: Regression based Algorithm for Change-Point Detection (RACHPoD) in Genomic Sequences
(Abstract Id: A12-13-060)

^aArfa Anjum, ^aSeema Jaggi and ^bEldho Varghese
^aICAR-IASRI, New Delhi, India
^bICAR-CCMRI, KOCHI, INDIA
anjum.arfa@gmail.com, seema.jaggi@icar.gov.in, eldhoiasri@gmail.com

Regression based Algorithm for Change-Point Detection (RACHPoD) in Genomic Sequences Arfa Anjum, Seema Jaggi, Eldho Varghese ICAR-Indian Agricultural Statistics Research Institute, New Delhi ICAR-Central Marine Fisheries Research Institute, Kochi Email : anjum.arfa@gmail.com Abstract Change point (or segmentation) are considered as a problem in genomics, which rises in many field of genomics such as Copy number variation, Gene detection, Protein-DNA interaction. They are faced as one deal with data as it is organized along one dimension (time, genome position) or expected to display abrupt changes or in presence of noises. Segmentation aims to find stability and homogeneity in the behavior of the process. It helps in identifying the moments of change, called change point. Change-points describe the boundaries between two dissimilar segments and help to understand biological locations of the start point of heterogeneity within a sequence of genome. A modified regression approach for the change points detection within segment is proposed. The proposed methodology is very well capable of detecting change points in a given genome sequence. Segments found by our algorithm can be used as a markers in a wide range of evolutionary studies. This study shows the segmental pattern of variations which can be applied in locating introns, sequence alignment, decomposition of long sequences into homogeneous pieces and evolutionary studies. Multiple factors such as Single nucleotide polymorphism (SNP) frequency, CpG island, CNV and any variable can be taken for further studies.

PP97: Forecasting Volatility in Agricultural Commodity Prices using Combination of GARCH and SVR model
(Abstract Id: A4-6-072)

Tanima Das, Ranjit Kumar Paul, L. M. Bhar and A. K. Paul
ICAR-IASRI, New Delhi, India
tanimadas5@gmail.com, ranjitstat@gmail.com, lmbhar@gmail.com, pal@iasri.res.in

Various important agricultural commodities mainly the perishable products depict volatility. Volatility forecasting is an integral part of commodity trading and price analysis. To forecast volatility, Autoregressive Conditional Heteroscedastic (ARCH) model was introduced by Engle (1982) to provide better estimate of variance and leading to ultimately better assessment of risk. The drawbacks of ARCH model necessitated the emergence of more parsimonious version i.e. GARCH (Generalized ARCH) model (Bollerslev, 1986). In many literatures, the inefficiency of single parametric model in capturing volatility in a series has been strongly proved. In this context non-parametric nonlinear model like Support Vector Regression (SVR) may be used to improve forecasting performance. Support Vector Machine (SVM) is a supervised machine learning technique introduced by Vapnik (1992). With some specifications it can be applied in regression problems as well as in time-series analysis. So, in search of an improved alternative to the classical econometric methods, machine learning technique viz. SVR is applied along with its combination with GARCH model. An algorithm has been proposed for combining two approaches namely, GARCH and SVR in order to forecast the time series under consideration. For the present investigation, monthly wholesale price of onion during the period January, 2004 to December, 2018 for two major markets in India namely Delhi and Kolkata has been used. The traditional GARCH model and the proposed algorithm i.e. GARCH-SVR technique are compared on the basis of their forecasting performance. To compare these results the validation set of 18 data points are used. This comparison is done on the basis of minimum Mean Square Error (RMSE), Mean Absolute Error (MAE) and the R^2 log values. The outperformance of the combination approach is established for the data under consideration.

PP98: Forecasting of Potato price using improved long memory model
(Abstract Id: A4-6-073)

Krishna Pada Sarkar, K N Singh, Amrit Kumar Paul, Ramasubramanian V, Mukesh Kumar, Achal Lama and Bishal Gurung
ICAR_IASRI, New Delhi, India
krishnapadasarkar07@gmail.com, kn.singh@icar.gov.in, pal@iasri.res.in,
R.Subramanian@icar.gov.in, Mukesh.Kumar@icar.gov.in, chllm6@gmail.com,
vsalrayan@gmail.com

Time series analysis and forecasting is one of the challenging issues of statistical modelling. Modelling and forecasting of price is very much needed for both the farming community and policy makers, especially in agriculture. Many real agricultural data, especially commodity price data exhibits the typical long memory feature i.e. having long range dependency. For capturing the long range dependency behavior of the data Autoregressive Fractionally Integrated Moving Average (ARFIMA) model is generally employed. In many practical situation besides the original time series, data on some auxiliary or exogenous variables may be available or can be made available with a lower cost; like besides the market prices of commodities, market arrivals for that commodity may be available and it affects the market price of commodities. This type of exogenous or auxiliary variables can be incorporated in the existing model for improving the model performance and forecasting

accuracy, like Autoregressive Fractionally Integrated Moving Average with exogenous variables (ARFIMAX) model. For the present investigation daily maximum and modal price of potato of Agra market of UP, India are taken along with daily market arrival. Both the ARFIMA and ARFIMAX model with market arrival as exogenous variable are fitted for the data under study. Comparative studies of the fitted models are employed by using the Relative Mean Absolute Percentage Error (RMAPE) and Root Mean Square Error (RMSE) criteria. We could establish superiority of the ARFIMAX model over the ARFIMA model in terms of modeling and forecasting efficiency.

**PP99: Augmentation of Standard Simplex-Lattice Designs
(Abstract Id: A0-0-001)**

Debopam Rakshit, Baidya Nath Mandal, Rajender Parsad and Sukanta Dash
ICAR-IASRI, New Delhi, India
rakshitdebopam@yahoo.com, bn.mandal@icar.gov.in, rajender.parsad@icar.gov.in,
sukanta.dash@icar.gov.in

In mixture experiments, it is assumed that the response is a function of the relative proportions of the ingredients or components in the mixture and the response does not depend on the total amount of the mixture used in the experiment. Augmentation of the design points of the standard simplex-lattice designs are needed for better exploration of interior portion of the simplex space. A new method of obtaining more design points by augmenting the design points of simplex-lattice designs for mixture experiments with three components is developed. For this purpose, a special property of equilateral triangles is used. From the geometry of triangle, it is known that any equilateral triangle can be partitioned into t^2 equilateral triangles, where t is a positive integer. Simplex space of standard simplex-lattice designs are divided into smaller equilateral triangles by this method. The centroid of these smaller equilateral triangles are included in the designs as augmented points. Design evaluation criteria namely D-efficiency per point and G-efficiency per point of these augmented designs are also studied to evaluate the efficiency of the obtained designs. These efficiencies are compared with previously used designs in agricultural experimentation with same number of design points.

**PP100: Rescaling Bootstrap variance estimation for Level-0 Ranked Set Sampling
under finite population framework
(Abstract Id: A1-1-082)**

Vinaykumar L N, Tauqueer Ahmad, Ankur Biswas, Anil Rai and Prachi Misra Sahoo
ICAR-IASRI, New Delhi, India
vinaymandya123@gmail.com, tauqueer@iasri.res.in,
Ankur.biswas@icar.gov.in, anil.rai@icar.gov.in, Prachi.Sahoo@icar.gov.in

Ranked Set Sampling (RSS) was introduced by McIntyre (1952) to improve upon Simple Random Sampling (SRS) for those situations where some preliminary ranking of sampled units are feasible for the character of interest by means of visual inspection or without actually quantifying the units. The Level-0 sampling protocol of RSS under the finite population framework as defined by Deshpande et al. (2006) is considered in this paper. Estimating the variance of the Level-0 RSS estimator under the finite population was found to be cumbersome. In this study, two different rescaling bootstrap variance estimation methods viz. Strata based Rescaling Bootstrap With Replacement (SRBWR) and Cluster based Rescaling Bootstrap With Replacement (CRBWR) are proposed in order to unbiasedly estimate the variance of Level-0 RSS estimator of a population mean. The two rescaling factors that are required to calculate the variance of the Level-0 RSS estimator were obtained. The results of the simulation study as well as real data application support that proposed methods are capable of almost

unbiasedly estimate the variance of the Level-0 RSS estimator. The SRBWR method performs better than the CRBWR method with respect to Relative Stability (RS) for different combinations of set size (m) and number of cycles (r).

PP101: Market integration and price transmission: A case of major potato markets in India
(Abstract Id: A4-6-074)

Rajeev Ranjan Kumar, Girish Kumar Jha
ICAR-IASRI, New Delhi, India
rrk.uasd@gmail.com, girish.stat@gmail.com

In this study, in order to provide insight on the dynamics of different potato markets, the concept of co-integration and the extent of price causality were analysed using monthly potato prices of different markets in India. Johansen's multivariate co-integration approach has been applied to identify the possible market integration. The results of overall co-integration test have indicated that different potato markets in India are well-integrated and have long-run price association across them, which revealed that the potato market has high efficiency. In other words we can say that even though the selected potato markets in India are geographically isolated and spatially segmented, they are well-connected in terms of prices of potato, demonstrating that the selected potato markets have long-run price linkage across them. To check the long run causality, we estimated error correction in the vector error correction model. To get the additional evidence as to whether and in which direction price transmission is occurring between the market pairs in short run, Wald test has been used. The impulse response functions were also conducted which have confirmed the results of co-integration and causality.

PP102: Kernelized Multi-Response LASSO for Multi Trait Genomic Selection
(Abstract Id: A12-13-061)

Neeraj Budhlakoti, D C Mishra and Anil Rai
ICAR-IASRI, New Delhi, India
neeraj35669@gmail.com, dwij.mishra@gmail.com, anilrai64@gmail.com

Genomic selection methods based on single traits has been successfully used in recent years. However accuracy of genomic selection methods based on single trait is still a challenge. As correlation among quantitative traits is prevalent in such type of breeding programs, which further suggest that these correlated traits may carry information over each other. At present genomic selection methods based on single trait could not able to take advantage of such kind of information. Genomic selection based on multiple traits could be helpful in this aspect but it has been not much more explored and implemented in practical breeding programme. There is lots of scope for improvement in accuracy using information on multiple traits. Here we have applied Multi Trait Genomic Selection (MTGS) based approach i.e. Kerenlized Multi response LASSO (KMLASSO) for genomic selection and we have also witnessed improvement in genomic prediction accuracy.

PP103: Past Versus Future Situations Regarding Cost of Cultivation of Major Crops in India: Implication to Doubling the Farmers Income

(Abstract Id: A4-6-075)

Manish Sharma, Sunali Mahajan and S E H Rizvi
SKUAST Jammu, Jammu, India

manshstat@gmail.com, sunali12mahajan@gmail.com, sehzvi_stats@yahoo.co.in

Today's situation reveals that the value addition per worker in agriculture grew slowly and income per farmer never crossed one-third of the income of a non-agriculture worker since the 1980s. The government released a four-volume report which projected that the central government's goal is to raise average annual incomes of agricultural households from Rs 96,703 in 2015-16 to Rs 1,93,406 in 2022-23. For this purpose, forecasting is the key tool to alarm about the need of nation in advance. In order to keep such points in consideration, the secondary data of cost of cultivation of major crops (Rice, Wheat and Maize crops) from 2004-05 to 2014-15 have been taken. In this study, the Box-Jenkins methodology has been applied and the time series model(s) have been developed in order to forecast the cost of cultivation of Rice, Wheat and Maize crops for India. Best model was selected on the basis of model selection criteria's i.e. AIC and SBIC. On the basis of these model selection criteria's, it has been found that the best model for cost of cultivation of Rice crop was ARIMA (0 1 1), for Wheat crop was ARIMA (0 1 1) and for Maize crop was ARIMA (0 1 1). The forecasted values for the cost of cultivation of Rice, Wheat and Maize crops for the year 2020-21 will be Rs 60495.90 per hectare, Rs 55631.66 per hectare and Rs 68682.53 per hectare. In Addition, the gain in profit percentage w.r.t cost has also been calculated for all the crops. It has been observed that the gain in profit percentage of Rice crop for the forecasted year 2020-21 on the basis of proposed model will be 120.08 percent, for Wheat and Maize it will be 59.77 percent and 62.85 percent respectively. On the basis of findings, it may possible to double the profit of Rice crop but not possible to double the profit of Wheat and Maize crops by the year 2020-21. Therefore, it need to give attention towards some recommended significant variables as per the Quantile Regression Model(s) for profit function of the respective crops which give benefits to the farmer in terms of doubling their income i.e; for rice, minimize :cost of seed, cost of insecticide and fixed cost; for wheat, cost of seed and irrigation charges; for maize, fixed cost.

**PP104: A Comparative Study of Tomato Crop for Jammu Division of J&K State:
Season Vs Year**

(Abstract Id: A3-15-004)

Ritika Mahajan, Manish Sharma, S E H Rizvi and MIJ Bhat
SKUAST Jammu, Jammu, India

guptaritika0902@gmail.com, manshstat@gmail.com, sehzvi_stats@yahoo.co.in,
jeelani.miqbal@gmail.com

This paper shows a behaviour and trend of Tomato crop for Jammu division of Jammu And Kashmir State on the basis of season as well as on average yearly basis. The information on Data relates to monthly price, arrivals, turnovers etc. have been procured from the J&K Horticulture Planning & Marketing Department, with effect from year 2012-2017. The major findings of the study revealed that the price variation in winter season is more than the summer season, arrivals showed the more variation in both the seasons as well as on yearly average basis but there was a drastic change in the turnovers in the year 2013-14 and 2017-18. Further, the area was more in the year 2013-14 i.e; 1828.00 hectare (hac.) but the production and yield were more in the year 2017-18 i.e; 42281.00 metric-tons (MT) and 24.65 Metric-tons per hectare (MT/hac.). On the basis of summary statistics, the average price was more in the winter season (1850.62 Rs/mtl), average arrival was more in summer season (24346.16 mtl) and the average turnover was more in winter (159611331.53). The yearly average area, production and yield were 1772.33 hac., 38267.18 MT and 22.21 MT/hac. The state government should take some initiatives in order to increase the production and yield rather than area so that it will minimize the prices in winter season and also educate the farmers to make

appropriate decisions regarding the production pattern of the Tomato crop.

PP105: Trend Free Partially Balanced Incomplete Block (TF-PBIB) Designs Useful in Agricultural Experiments
(Abstract Id: A12-13-062)

^aRahul Kumar Gupta, ^aArpan Bhowmik, ^aSeema Jaggi, ^aCini Varghese, ^aMd. Harun and ^bEldho Varghese

^aICAR-IASRI, New Delhi, India

^bICAR-CMFRI, Kochi, India

rahul.iasri1@gmail.com, arpan.bhowmik@icar.gov.in, seema.jaggi@icar.gov.in,
cini2204@gmail.com, harun.agribhu@gmail.com, eldhoiasri@gmail.com

Generally, in the design of experiments, especially in agricultural experiments, when the heterogeneity in the experimental material is in one direction only, block designs are the most commonly used designs. In agricultural experiments under block design set up the response of plots within the block may significantly be affected by the systematic trend. Therefore, if there is evidence of the presence of trend then it becomes necessary to incorporate the trend component in the model and the arrangement of the treatments within a block is need to be obtained in such a way that there is no effect of the trend on the response of experimental units. Such arrangements of the treatments are known as trend free designs and since the obtained designs are linearly trend free, incomplete and partially balanced, they are known as linearly trend free partially balanced incomplete block (TF-PBIB) designs. In this paper, the developed method for obtaining linearly TF-PBIB designs for any number of treatments has been discussed and properties of the obtained designs have been highlighted.

PP106: Trend Analysis of Basmati Rice Production in Jammu District of J&K
(Abstract Id: A4-6-076)

Chetna Skolia, S E H Rizvi, Manish Sharma and MIJ Bhat

SKUAST Jammu, Jammu, India

chetnaskolia@gmail.com, sehzrizvi_stats@yahoo.co.in, manshstat@gmail.com,
jeelani.miqbal@gmail.com

Rice is the main food source for more than half of the world's population. Basmati rice holds a unique position due to its fragrance, aroma, grain morphology, quality and other desirable traits. India is the world's leading producer and exporter of Basmati Rice with an annual production of 60 lakh tonnes, contributing over 70% of the world's Basmati rice production. In Jammu and Kashmir, Basmati is grown in the region of Jammu. In J&K total Basmati acreage area was 62.37 (000'ha) and production 135(000'tons) (Kharif 2018, Report-6 APEDA). Keeping in view the importance of Basmati rice, the present investigation has been done to assess the trend and analysing it through parametric trend models for Basmati Rice Production in Jammu District of J&K. For this purpose all the erstwhile 8 blocks under Jammu district viz. R.S Pura, Miran Sahib, Arnia, Satwari, Bishnah, Mandal Phallian and Marh were taken. Secondary data on production of Basmati rice in Jammu district were obtained from Department of Agriculture, Jammu covering the period from 2005 to 2018. On the basis of time series data set for the last 14 years, the overall average area under basmati rice in Jammu was obtained as 28836.21 ha whereas average production was 788218.07 q giving overall average productivity as 27.33 q/ha . The trend of each block showed marginal change in production till 2016 thereafter it showed significantly increasing trend. However, there was overall huge decrease in production of Basmati rice in 2014 (473131 q) which was due to excessive rainfall in the entire basmati growing areas of Jammu region. Different Time series models were obtained for production

of Basmati, block wise as also for entire Jammu district. On the basis of R² and adj. R², the best four models were selected. Among these models cubic model, obtained for overall production in Jammu as $\hat{Y}=424331.276+2.499t-7.033t^2+5.483t^3$, was found to be best fitted (p-value < .001). Based on this time series model, the predicted production of Basmati rice for Jammu district in year 2019 is expected to be 1751419.04 q with 95% confidence limits (1255976.57, 2246861.51). The overall C.V. was calculated as 31.77% whereas the instability index was 13.63.

PP107: Forest Resources with Emphasis on Production and Utilization of Non Timber Forest Products of India
(Abstract Id: A7-9-034)

Girish Chandra
Indian Council of Forestry Research and Education, Dehradun, India
gchandra23@yahoo.com

Forest contributes to the economy of India by the way several products like timber, Non Timber Forest Products (NTFPs), fuel-wood, etc. Much of the contribution goes unaccounted for as they contribute to subsistence of the forest dependent communities and hence are not generally measured directly. NTFPs has been recognized as a major sector under forest and forest products in India. After the implementation of the Indian Forest Policy of 1988, NTFPs have gained significance as they could be sustainably harvested and, unlike timber, did not take a long to replenish. They also did not resort to large scale plunder of forests leading to their degradation. Owing to such forestry produce, the contribution of forests to the economy also increased besides adding to the gross value. The present study provides the status and analysis of forest resources based upon the available data from 2010 onwards. The resources includes timber, fuel-wood, NTFPs etc. More emphasis is given to the NTFPs along with their estimation methods.

PP108: Bridging the Digital Divide in India
(Abstract Id: A12-13-063)

Chavi Asrani,
Indian Institute of Technology-Delhi, New Delhi, India
chaviasrani@gmail.com

Information and Communications Technology (ICT) revolution has radically improved global connectivity and integrated into diverse aspects of modern human life, positively impacting economic growth and welfare. ICT has emerged as the tool for the delivery of developmental services such as healthcare, education, financial service, e-governance, e-commerce, especially in the underserved areas. ICT services have enhanced system efficiency by reducing information asymmetries with better knowledge sharing and there by allowed better functioning of across markets. Scholarship in-fact observes that ICT impacts the growth of developing economies more as compared to the advanced economies. The United Nations also recognises ICT as a critical enabler of progress towards achieving the MDGs and the SDGs. World's largest democracy and the second most populated country, India is much a part of the cutting edge technological revolution. India's digital adoption has been rapid since the year 2000, but India still lags in ICT adoption compared to the rest of the world. Additionally, India's ICT adoption has been an urban phenomenon with substantial disparities among the Indian states. Research explains that socio-economic disparities, associated with differences in ICT adoption, could further intensify if the existing digital gap is not bridged. Thus there exists a significant threshold for policymakers. Further, ICT services exhibit positive network externality, the value of service grows as more users subscribe to the service, as it escalates the potential number of

communications patterns. With the increased communication patterns the economic activity grows as more economic agents can collaborate, thereby increasing business activity. Also as the number of subscribers in a particular geography increase, the cost of providing services to a specific user in a particular location reduces due to the economies of scale. But, ICT utilities also face a risk of a congestion externality, as the infrastructure utilisation moves towards its full capacity utilisation; the service quality could deteriorate, which makes capacity planning crucial. To take better policy decisions for bridging India's digital divide it is imperative to understand the factors influencing the adoption and diffusion of digital communications in India. This study identifies the diffusion pattern of digital communication in India while accounting for technological augmentation and estimates the future levels of ICT penetration in the country. Further, the study surveys the factors influencing the variation in regional ICT adoption in India and validates the Rogers theory of innovation diffusion by investigating how the social system impacts technology adoption at different penetration levels. The findings will be useful for infrastructure capacity planning, taking strategic management decisions and projecting the diffusion process of the emerging technologies.

**PP109: Outlier Robust Finite Population Estimation under Spatial Non-stationarity
(Abstract Id: A1-1-083)**

Pramod Kumar Moury, Tauqueer Ahmad, Anil Rai, Prachi Misra Sahoo and Ankur Biswas
ICAR-IASRI, New Delhi, India
12pkm7@gmail.com, tauqueer@iasri.res.in, anil.rai@icar.gov.in, Prachi.Sahoo@icar.gov.in,
Ankur.biswas@icar.gov.in

When outliers appears in survey data obtained from population exhibit spatial non-stationarity, the use of conventional estimators to estimate the finite population total may not be appropriate. Spatial non-stationarity is a condition when the measurement of relationships among variables differs from location to location whereas that remains constant in spatial stationarity condition. Standard regression model fails in this situation. Geographical weighted regression (GWR) is a local spatial statistical technique used to deal with spatial non-stationarity. In this study, some outlier robust GWR estimators have been proposed to estimate the finite population total for above mentioned condition. Also a comparative simulation study of proposed estimators, standard outlier-robust estimator and standard GWR estimator of finite population total has been conducted. It has been observed that proposed estimators perform fairly well in a scenario where spatial non-stationarity appears in population and the population under consideration is outlier prone.

**PP110: Chiastic Clipping Signal-Based Algorithm for Identification of Signals
Responsible for Stress Tolerance Mechanisms ensuring Nutritional Security in Legume
Crops
(Abstract Id: A1-1-083)**

Tanwy Dasmandal, Sarika Sahu and A.R. Rao
ICAR-IASRI, New Delhi, India
tanwydasmandal20@gmail.com, sahusarikaiiita@gmail.com, rao.cshl.work@gmail.com

Leguminous crops are important crops next to cereals. The production and productivity of legume crops have a major impact on world's economy as well as the economic status of the farmers.

Moreover, better nutrition was recognised in SDG 2, which aims to end hunger, achieve food security and improved nutrition, and promote sustainable agriculture. Thus, nutritional security can be ensured through growing of leguminous crops like chickpea and soybean. With the advent of advanced data analytics and algorithms, it has become feasible to unravel the underlying complex genome level mechanisms involved in the augmentation of nutritional status in the said crops. Even though the coding genes play a role in regulating drought(abiotic) stress tolerance and wilt(biotic) disease mechanisms, there are several signals, which regulate the genes responsible for stress tolerance mechanisms. However, the identification and characterization of such signals in chickpea and soybean have not yet been fully explored. Hence, a study has been taken up to accurately predict the signals responsible for stress tolerance mechanisms in chickpea and soybean by applying a novel Chiastic Clipping Signal-Based Algorithm (CCSBA) and various filtration strategies.

**PP111: Evaluation of the robustness of imputation methods combined to backpropagation algorithm in frame of multiple non-linear regression
(Abstract Id: A1-1-061)**

^aCastro G. Hounmenou, ^bBoris M. Behingan, ^aKossi Esson Gneyouc and
^cRomain Glele Kakaï

^aUnité de Biomathématiques et statistique, Laboratoire de
Biomathématiques et d'Estimations Forestières, Abomey-Calavi, Bénin

^bProduction Animale, Faculté des Sciences Agronomiques, Abomey-
Calavi, Bénin

^cMathématiques, Faculté des Sciences Techniques, Lomé, Togo
castrohounmenou@gmail.com, begboris@yahoo.fr,
kgneyou@gmail.com, glele.romain@mail.com.

Missing data management for prediction purposes is an important issue in data analysis. This study aims to evaluate the efficiency of imputation methods combined with the backpropagation algorithm in a nonlinear regression context. The evaluation is conducted through a simulation study including sample size (50, 100, 200, 300 and 400) containing different missing data rates (10, 20, 30 40 and 50 %) by considering three missingness mechanisms (MCAR, MAR and MNAR). Four imputation methods (Last Observation Carried Forward, Random Forest, Amelia and MICE) were used to impute datasets before making prediction with backpropagation. 3-MLP model was used by varying the activation function (Logistic-Linear, Logistic-Exponential, TanH-Linear and TanH-Exponentiel), the number of nodes in the hidden layer (3-15) and the learning rate (20-70 %). The analysis of the performance criterion (R^2 , r and RMSE) the network produced good performances when it's trained with TanH- Linear activation as function, 11 nodes in the hidden layer and a learning rate of 50 %. MICE and Random Forest were more appropriate for data imputation. These methods can support up to 50 % of missing rate at an optimal sample size of 200

**PP112: Integrating data from census of agriculture and disease control: An empirical study for the Brazilian state of Tocantins
(Abstract Id: A1-1-009)**

^aRaphael Molina Guimarães, ^aAndrea Diniz da Silva and ^bGeremias de
Mattos Fontes Neto

^aMethodology Department, IBGE - Brazilian Institute of Geography and

Statistics, Rio de Janeiro, Brazil
^bAgricultural Statistics Department, IBGE - Brazilian Institute of
Geography and Statistics, Rio de Janeiro, Brazil
ramguimaraes@yahoo.com.br, andrea.silva@ibge.gov.br,
geremias.neto@ibge.gov.br

Most Brazilian agricultural statistics are still based on decennial censuses, surveys over subpopulations of establishments and subjective surveys. Together, those sources provide an important range of high quality data. However, there exist some limitations such as the natural obsolescence of census data as time passes and the impossibility of providing error estimates or precision measurement associated to the subjective surveys. To improve agricultural statistics, the Brazilian Institute of Geography and Statistics – IBGE plans to conduct a probabilistic survey compatible with the Agricultural Integrated Survey – AGRIS as well as improve Register Based Agricultural Statistics. A sampling frame to support the survey as well as an Agricultural Register will be built based on the 2017 Census of Agriculture. Strategies for updating both considers data integration using administrative data from registers managed by IBGE and other Government sources. Setting a Data Integration method requires, among other tasks, fitting a record linkage method to identify records referring to the same producer, therefore can be combined to update information already in the frame; and records referring to new producers which can be added to the frame. A complete data integration exercise using unique ID, coordinates, name and address as linking variables; as well as a preliminary study to find the best tolerance limit for difference between coordinates values in registers referring to the same producer, are presented. Results are based on an empirical study using registers from the disease control agency in the State of Tocantins and the 2017 Brazilian Census of Agriculture.

**PP113: Improving paddy statistics in Indonesia: Implementation of a crop
cutting survey using area sampling frame
(Abstract Id: A1-1-010)**

Ratna Rizki Amalia and Kadir
Directorate of Food Crops, Horticulture, and Plantation Statistics, BPS-
Statistics Indonesia, Jakarta, Indonesia
ratna.amalia@bps.go.id, kadirsst@bps.go.id

In improving the accuracy of paddy statistics, BPS-Statistics Indonesia in collaboration with the Agency for Assessment and Implementation of Technology (BPPT) has developed an objective measurement based on area sampling frame (ASF) technique to estimate the area harvested of paddy since 2015. This effort was aimed to obtain a more accurate paddy production figure in Indonesia, which is a multiplication product of two variables, namely the area harvested and productivity (yield per hectare). The former variable has been suspected as the main source of an upward bias (overestimation) in production data since it was collected through a subjective measurement, mainly "eye-estimate" method. Although the official figure of production data that was fully based on objective measurements was successfully released in 2018 for the first time, the productivity data is still obtained through a crop-cutting survey that is conducted based on a list frame (households) instead of an area frame. The use of a list frame has several limitations such as a high non-response rate that affects the accuracy of estimation. This issue has motivated BPS- Statistics Indonesia to integrate both ASF to estimate the area harvested and the crop-cutting survey to obtain the productivity estimation in the same data collection process. In other words, the crop cutting survey

also is going to make use of an area frame instead of a list frame. By doing so, there is no need to conduct a household listing for the sampling frame, which is quite time consuming and costly. Therefore, the implementation of the crop cutting survey will become more efficient and faster than before. The aim of this paper is to give an explanation about the technicalities that are going to be implemented regarding the integration. The explanation would be focused on the methodology that is going to be applied and the business process of the data collection. The results can be used as a policy reference to strengthen agricultural data in official statistics in Indonesia that seriously develop a new methodology for collecting accurate rice production data.

PP114: Estimation of current population mean using two-occasion successive sampling with one auxiliary variable
(Abstract Id: A1-1-038)

R. Zoramthanga
Community Medicine, Zoram Medical College, Aizawl, India
aramaralte7@gmail.com

Estimation of finite population mean on the current occasion based on the samples selected over two-occasion successive sampling has been considered by the (Singh, 2005, Ralte and Das, 2015). In this study, two-occasion successive sampling for ratio-to-regression estimator was used to determine the current estimate of the population mean using only the matched part and one auxiliary variable, which is available on both the occasions. The data used were based on the total number of female workers in villages in Mizoram with the total number of literate females in villages in Mizoram as an auxiliary variable. The data were gotten from Census of India 2001 and 2011. The optimum mean square error of the combined ratio-to-regression and ratio estimator has been compared with (i) the optimum mean square error of the chain-type ratio estimator mean per unit estimator and (iii) combined estimator when no auxiliary information is used at any occasion. This result showed that the combined ratio-to-regression and ratio estimator is more efficient than the other three existing estimators.

PP115: Post-stratified estimator in successive sampling
(Abstract Id: A1-1-054)

Manish Trivedi and V. K. Singh
School of Sciences, Indira Gandhi National Open University, New Delhi,
India
manish_trivedi@ignou.ac.in, vijay_usha_2000@yahoo.com

The technique of post stratification is used when frames of each stratum are not available while performing stratified sampling in surveys. It is oftenly seen that a population having large number of elements remains unchanged over several occasions but the value of units changes over time. In such situations, if the aim is to observe pattern of changes in certain characteristics over time; sample surveys are also not limited to only one-time period, rather it is repeated over a fixed period of time. In this paper, an estimator of population mean of current occasion is proposed assuming that the survey is repeated a number of times. The population observed at several occasions has been assumed to be a stratified population such that frames of each stratum are not available. Minimum variance of the optimum estimator is derived and a comparative study of the proposed estimator is incorporated.

An optimum weight structure is taken and an unbiased estimator is proposed which is efficient over post- stratified estimator. An estimation strategy is proposed and optimum properties are derived. Intensive database study is incorporated in the paper to support the theoretical findings.

PP116: A graphical analysis on growth and development pattern of sugar cane
(Abstract Id: A1-1-069)

^aDebjani Pandit and ^bO P Dubey

^aAgriculture Department, Roorkee College, Roorkee, India

^bCivil engineering, Roorkee College of Engineering, Roorkee, India
debjani3p@gmail.com, opdubey11@gmail.com

In this paper, the paramount focus is kept to study the growth pattern of the sugarcane crop. Sugarcane is one of the most prominent cash crop for India. The sugarcane production contributes around 6% of the total agriculture GDP .sugarcane is the prime source of sugar in India. Sugarcane is not only contributing in the primary sector but also playing an important role in the secondary sector. The sugarcane fibers are also used in the production of paper, beverages, khandasi and various chemicals. As India comes under subtropical region it is more cardinal for us to study about its growth and development pattern as it is actually a tropical crop. To succeed in the cultivation of sugarcane in the subtropical region it is must to understand it's growth and development. The paper provides a graphical illustration on the growth of sugarcane crop. In this paper the best-suited curve for the growth of sugarcane has been identified after various trials. The trial is done irrespective of considering any external or internal factors. Thus, the paper basically analyzed the best-suited curve for sugarcane crop

PP117: Agricultural statistics in Zimbabwe
(Abstract Id: A1-1-014)

Chinyanya Christopher

Zimstat, Zimstat, Harare, Zimbabwe
chrischinyanya@gmail.com

Zimbabwe National Statistics Agency (ZIMSTAT) is the government agency mandated to provide agricultural statistics in line with the Sustainable Development Goals (SDGs) indicators and give support and guidance to stakeholders in the National Statistical System (NSO) for conducting censuses and surveys of agriculture. This research will mainly focuses on the role played by agricultural statistics to measure production, yield and production forecasting. This is in line with the of the ICAS-VIII 2019; Statistics for Transformation of Agriculture to Achieve the Sustainable Development Goals (SDGs) Surveys are conducted following internationally agreed methodologies to allow for international comparison. The main objective of agricultural statistics is to provide planners and policy makers with necessary information for both short and long term strategies for dealing with food supply situation in the country and the formulation of agricultural related policies. Agriculture statistics through surveys and data analysis and integration play a pivotal role in the provision of benchmark data on cultivated areas and cropping patterns, yield estimate, fertilizers used and other crop inputs, credits and loans, and transport and fuel costs. The statistics are used for economic analysis of the agriculture industry, planning, compilation of Gross Domestic Product (GDP) and assessing the food security in the country. During data collection, questionnaires are administered by

well-trained enumerators within each enumeration area for the six agricultural sectors and thorough data editing and supervision is done in the field. Data is captured using CSPro computer package and SAS is used for data analysis. Although there are other methods or ways to measure yield and production forecasting like Geographic Information System (GIS) through remote sensing, surveys such as area measurement are carried out to measure the area under by crops, forecasting production and yield through linear regression model. Multiple-Linear regression can be used to find the influence of area planted, crop inputs, loans and credits and other technological improvements, on yield and production. Through the agricultural surveys, agricultural statistics can be used to the measure the farmers' loss after harvesting through post-harvest loss measurement surveys. This will measure the amount of production a farmer losses out through pests, parasites and poor conditions in storage facilities and some recommendations are on how to mitigate on the losses. Through data analysis trend of the agricultural statistics are used to assess the food supply patterns by policy makers for intervention should the need arises. This would guide the government on the position of food security and would lead to either importation or exportation food. Over the past five years, production and yield of grain crops have been slowly decreasing at a decreasing rate. This is mainly due to climate changes that drive low rainfall patterns. Agricultural statistics results are thoroughly verified by well trained personnel and are disseminated through workshops, main stream media, website publications, local and international events.

PP118: Application of joint generalized linear models in examining physical support factors influencing crop yield in northern Ghana
(Abstract Id: A1-1-059)

Smart A. Sarpong
Institute of Research, Innovation and Development, Kumasi Technical
University – Ghana, Kumasi, Ghana
smart.asarpong@kstu.edu.gh

This study attempts to formulate a model for examining physical support factors that influence crop yield in Northern Ghana. The focus is to compare the classical Generalized linear model to the Joint generalized linear models and to select the very best factors based on the best of the two models. Analysis is based on raw data available at the regional Monitoring and evaluation office of the linking farmers to market (FtM) project in Tamale Ghana. We settle on the Joint GLM for inference and selects access to credit facility, Crop type, Networking among farmer groups, access to post-harvest equipment, the number of farmers on site and Plot size as the most important physical support factor that influence crop yield in Northern Ghana.

PP119: ARIMA model for forecasting of production & yield of black gram in Odisha
(Abstract Id: A1-1-068)

Subrat Kumar Mahapatra and Abhiram Dash
Department of Agricultural Statistics, Odisha University of Agriculture
and Technology, Bhubaneswar, India
smsubrat362@gmail.com, abhidash2stat@gmail.com

An experimental study was conducted on forecasting of time-series data of production & yield of a Black gram in Odisha. The Autoregressive Integrated moving average (ARIMA) model are fitted to the original time series data as well as the first difference data to check the stationarity. The data from 1971-72 to 2006-07 are used for model building and from 2007-08 to 2015-16 used for successful cross-validation of the selected model on the basis of absolute percentage error. The different ARIMA models are judged on the basis of Autocorrelation Function (ACF) and Partial autocorrelation Function (PACF) at various lags. For forecasting production & yield ARIMA (1,1,0) without constant, ARIMA (0,1,1) without constant are found as the best-fitted model on the basis of the low value of Root Mean Square Error (RMSE) & Mean Absolute Percentage Error (MAPE). The best fitted ARIMA model has been used to forecast the production & yield for the year 2016-17 to 2018-19. The model showed the production forecast for the year 2018-19 to be about 246.50 ('000 tonnes) with lower & upper limit 6.96 ('000 tonnes) & 506.03 ('000 tonnes), respectively. Similarly, the yield forecast for the year 2018-19 is 221.45 kg/ha having lower & upper limit 90.36 kg/ha & 392.89 kg/ha respectively.

PP120: Evaluation of crop performance through wheat based crop modelling of north-west IGP
(Abstract Id: A1-1-066)

^aSunil Kumar, ^aChethan Kumar, ^bP. Kashyap, ^aL.K. Meena, ^cA.L.Meena,
^cP.C.Ghasal, ^cJairam Chaudhary and ^dA.S. Panwar

^aCropping systems and Resource Management, ICAR-IIFSR,
Modipuram, Meerut, India

^bTransfer of Technology and Human Resource Development, ICAR-
IIFSR, Modipuram, Meerut, India

^cOrganic Agriculture Systems, ICAR-IIFSR, Modipuram, Meerut, India

^dDirector, ICAR-IIFSR, Meerut, India

snandal15@yahoo.com, chethan1612@gmail.com,
pakhihorti@gmail.com, lalit.thoorwal@gmail.com,
amrit.iari@gmail.com, pcghasal@gmail.com,
jairam2011iari@gmail.com, director.iifsr@icar.gov.in

Abstract An Integrated Farming System (IFS) model ver. 1.1 that works on general farm data that could meet the needs of growing community of end-users exemplified by set of wheat crop growers is calibrated using wheat crop data of north-west Indo-Gangetic plains. This farm simulation model was used to analyse the effects of nutrient amendment and pond soil on yield of wheat and effect of climatic parameters like sunshine and rainfall on crop performance which was then used to calibrate the model for experimental field of institute's study site. Using data the model was validated over next year crop cycle at the farm scale. This study also deals with the discussion that how the integrated farming system (IFS) ver. 1.1 model is developed simulating the situations faced by farmers of western Uttar Pradesh with desired technological modifications needed to boost the farmers' productivity and profitability on sustainable basis. By management practices which are in control and practically feasible by farmers for example: like date of sowing and application of non-chemical nutrient amendments, farmers can earn better net profitability with lesser annual cost of cultivation with overall holistic benefit-cost ratio. The five parameters related to grain yield of wheat viz days taken to booting, days to anthesis, days to milking stages, days to dough stages and days taken to ripening significantly contribute in the determination of grain yield of wheat. The coefficient of determination $R^2=0.948$ is calculated following the stepwise regression analysis. The regression equation $\{(\text{Grain Yield (kg/ha)} = 2865.245 + 73.92 * (\text{Dough stage}) \}$ was fitted in the model for

development of the software for decision support systems as a wheat component/module. The results reveal that technological interventions on the basis of land use planning the system can fetch better gains and livelihood through their farms. This model can act as an innovative tool to transform less remunerative farm production systems into highly remunerative systems using available farm resources to generate better sustainable farm gains. Suggested model can also be useful in teaching processes involved in the system and its behaviour in response input variables.

**PP121: On estimation of crop yield for implementation of crop insurance scheme in
India
(Abstract Id: A1-1-008)**

^aU C Sud, ^aSD Sharma and ^bA K Srivastava

^aFormer Director, ICAR- IASRI, New Delhi, India

^bFormer Joint Director, ICAR- IASRI, New Delhi, India

dr.ucsud@gmail.com, sdsharmaus@gmail.com, arunsrivast@gmail.com

Crop Insurance is a technique to protect farmers in the event of crop yield loss due to natural causes. Thus by a paying a small amount of premium the farmer gets the right to be compensated in the event of yield loss due to natural causes. The Crop Cutting Experiments (CCE) technique is used in India for yield estimation. Further, Area based approach is used for implementation of crop insurance scheme. Thus, an area is defined and all the farmers belonging to the defined area will be deemed to have suffered yield loss if the area show evidence of yield loss. An area is said to have occurred yield loss if crop yield is less than the threshold yield. Accurate estimation of crop yield at the defined area level is thus crucial for proper implementation of crop insurance scheme in India. The defined area was designated to be a district when the crop insurance scheme started in India. Since the General Crop Estimation Scheme (GCES) was already in place for estimation of crop yield using CCE technique at district level, the crop insurance scheme continued without any problem. Subsequently, it was felt that a district is too large a geographical unit for implementation of crop insurance scheme. Accordingly, the defined area was reduced to a Community Development Block (CDB). This had immediate statistical implications- increase in sample size for yield estimation at CDB level. Fortunately, the increase in sample size was within the reach of Government (in terms of manpower, budget, infrastructure). Thus, the crop insurance scheme continued uninterrupted with defined area being a CDB. The National Agricultural Insurance Scheme (NAIS) was launched in 1999 whereby the defined area was further reduced to Gram Panchayat (GP). An implication of this development was steep rise in number of CCE for yield estimation at GP level. Carrying out so many CCEs was impossible for Ministry of Agriculture, Government of India. An alternative technique based on combining farmers' appraisal data and CCE data was proposed for yield estimation at GP level. The farmers' appraisal data was used to generate correction factors to be applied to CCEs based production estimates at CDB level to scale down the CDB production estimates to GP level. The methodology proposed was applied in Basti district in India using CCEs and farmers' appraisal data. The results revealed that the percentage standard errors for crop yield estimates at GP level were less than 10 percent in large numbers of GPs in the district suggesting thereby that the proposed methodology is sound. The proposed methodology has several advantages. Cost of data collection in the proposed methodology is substantially less, as compared to CCE approach, as CCEs data and farmers' appraisal data are suitably combined for yield estimation. Moreover, the approach if adopted is not likely to affect the existing system of GCES. Also, farmers' appraisal data collection in this approach can be entrusted to an alternative agency utilizing village resources e.g. unemployed youth who can be paid on questionnaire basis.

**PP122: Statistical downscaling for monthly and seasonal scale prediction of rainfall and temperature for climate risk management in agriculture
(Abstract Id: A1-1-032)**

U.C. Mohanty
School of Earth Ocean and Climate Sciences, IIT Bhubaneswar,
Bhubaneswar, India
ucmohanty@iitbbs.ac.in

The advance accurate information on monthly and seasonal scale precipitation and temperature (minimum, maximum and mean temperatures) is an important for planning most of the agricultural practices (such as a type of crops, and showing and harvesting schedules) and also useful for other allied sectors which is directly linked to the socioeconomic growth of the nation. With large sectors at stake due to monthly and seasonal scale rainfall and temperatures, the demand for a skillful prediction on these time scales have been ever increasing. It is well known fact that the performance of the global models over India is poor. Thus, there is a need to generate the skillful monthly and seasonal scale rainfall and temperature predictions at regional level with sufficient lead-time (in advance) for various risk management sectors. In the present study at IIT Bhubaneswar, a hybrid integrated methodology namely Extended Range forecast system (ERFS) has been developed for generating the monthly and seasonal scale rainfall and temperature predictions at each 34 met-subdivisions of India for the four distinctive seasons with a month in advance. The results clearly reveal that the ERFS show higher correlation and phase coherency along with lesser RMSE values in predicting the monthly and seasonal scale rainfall and temperatures than the individual GCMs, simple mean of all raw GCMS and bias corrected GCMs during all the seasons in majority of the subdivisions for the hindcast period (1982-2008). The confidence maps as a percentage of success of the ERFS real-time forecasts (2009-2017) is also shows that the success of hits of ERFS is highly significant in most of the months as well as all the seasons in majority of the subdivisions. The ERFS has made a jump from all-India scale to met-subdivision scale with satisfactory prediction skill and higher confidence. The application of ERFS real-time experimental forecasts in agriculture has been investigated for both Rabi and Kharif crops using crop simulation model. It is emerged from the results that the crop yield prediction is reasonably well which can be helpful to the agro-met advisory.

**PP123: Analysis of rice demand among peri-urban households in the federal capital territory, Abuja, Nigeria.
(Abstract Id: A1-1-041)**

Cornelius Owoniyi Adebayo
Agricultural Economics and Farm Management, Federal University of
Technology, Minna, Nigeria
cornelius.adebayo@futminna.edu.ng

The demand for Rice in Nigeria has been increasing at a much faster rate since the mid-70s. This research was undertaken to analysis rice consumption among peri-urban households in Federal Capital Territory using household consumption data elicited from a sample of 245 households through the instrumentality of a structured questionnaire. The data were analyzed using descriptive statistics, budget share index, regression and Linear Approximate-Almost Ideal Demand System model (LA-

AIDS). The mean age of household heads was 36 years with an average of five (5) members per household. Respondents were generally civil servant with an average income (farming and non-farming) of N190, 302 per month. The results of the budget share index indicated that the household's monthly budget share on rice was 0.17 which indicates that the households spend 17% of their monthly food expenditures on rice consumption. The result of the LA-AIDS model showed that the price of rice ($p<0.01$), stone price ($p<0.1$), monthly income ($p<0.01$) were all significant in influencing the households' demand for rice. In the light of the findings of the study, it was recommended that the current rice policy under the Federal Ministry of Agriculture and Rural Development's "Road Map", aimed at reducing the cost of local rice production, competitiveness and increasing supply should be sustained, as this will reduce the prices and invariably enhance demand for local rice by households.

**PP124: Agricultural census in the framework of an integrated data collection system
(Abstract Id: A2-2-014)**

Dokodjo Kodjo
Ministry of Agriculture, Agricultural Statistics Service, Lomé, Togo
dkkodjo@yahoo.fr

The integrated data collection system in Togo includes census of agriculture, agricultural surveys, thematic surveys and current statistics (agricultural commodity price for example). When data collection is integrated, data to be collected are harmoniously distributed among data collection activities. In this way, no data collection is carried out in isolation, but coordinated and concerted. The last census of agriculture in Togo carried by the Agricultural Statistic Service took place in 2012 and was conducted according to the modular approach of the FAO 2010 World Programme for the census of agriculture (complete enumeration for core module and community data and sample enumeration for supplementary and thematic modules). This approach allowed the articulation of the census into an integrated system of census of agriculture, agricultural surveys and thematic surveys. It is impossible to consider an integrated data collection system if census of agriculture is not carried out beforehand. The provision of frames for agricultural surveys and thematic surveys and the common use of concepts, definitions and classifications in both data collection activities are the tools to create this integration. The 2012 census of agriculture in an integrated data collection system has significantly contributed to improve agricultural and rural statistics. However, the approach has involved a multi-year programme of statistical activities, including agricultural census, agricultural surveys, thematic surveys and current statistics, to provide all the data required. It has let to plan and develop a comprehensive statistical programme without duplication of statistical activities or the release of conflicting statistics. Concepts, definitions and classifications used in the different statistical activities have been made compatible, making it easier to interpret and analyze related data from different sources. The agricultural census of 2012 in Togo has allowed to build an integrated data collection system of which the census is the nucleus that supports a multi-year statistical activity programme. This paper highlights the role of the 2012 agricultural census of the country in an integrated data collection system.

**PP125: Producing and disseminating more and better agriculture data for SDGs
in Egypt: Progress and challenges
(Abstract Id: A3-5-001)**

Waleed Mohammed
The sustainable development Unit, Central Agency for Public
Mobilization and Statistics, Cairo, Egypt
kant2012xp@hotmail.com

In September 2015, the United Nations launched the sustainable development goals (SDGs), Egypt was one of the 193 countries that adopted the SDGs and ratified the related agreements. Starting from 1 January 2016, the 2030 Agenda for Sustainable Development, including the 17 Sustainable Development Goals (SDGs), replaced the Millennium Development Goals, reshaping national development plans over the next 15 years with, among others, the new global objectives of ending poverty and hunger, responding to climate change and promoting the sustainable use of natural resources, and food security and agriculture lying at the heart of this new global strategy ; because it has the most direct impact on development aims related to rural development, natural resources and the environment, and also indirectly effects on the other sectors. So Sustainable development also requires a re-thinking of rural development and smallholder agriculture to bring greater benefits to the poor people, Structural formations of farming systems, technologies and business models are needed to enhance productivity and market participation and to create new job opportunities. On the other hand, the success of the SDGs rests to a large extent on new and effective ways of collecting data and measuring progress for a global indicator framework comprising a proposed 232 indicators to monitor the 169 targets is the foundation of the SDGs' accountability structure. The sheer weight of indicators, however, represents an immense challenge for countries; four times greater in number than for the MDGs, each indicator is also set to be disaggregated by gender, age, income, geography, occupation etc. to reflect the 2030 Agenda's guiding principle of "leaving no one behind". Based on above and to meet the ambitions and demands of the 2030 Agenda, the National Statistical Office (NSO) in all over the world has started to review their statistical survey, capabilities and their statistical programs to monitor the challenges of measuring and follow-up SDGs, so This paper aims to discuss the efforts exerted by NSO in Egypt to assess the current status for agriculture indicator (21 indicators) , and the challenges of assessing and monitoring it this besides Shed light on the technological innovations for dissemination agriculture data related SDGs for all data users to benefit from it in the decision-making in all fields.

**PP126: Mapping monthly paddy cultivation area in Indonesia using sentinel-1 images
through google earth engine
(Abstract Id: A2-3-004)**

^aThorp, Kelly and ^bDrajat, Dena

^aUS Arid-Land Agricultural Research Center, USDA, Arizona, USA

^bFood Crops Statistics, BPS, Statistics Indonesia, Jakarta, Indonesia
Kelly.Thorp@ars.usda.gov, dena@bps.go.id

Rice is one of the most important food resources across Asia, including Indonesia. Therefore, paddy rice mapping and monitoring are crucial to support policy formulation for promoting food security. Since 1973, statistics of rice crops in Indonesia has been based on administrative reporting systems. Data is collected by the lowest government unit, then transmitted to the next level in the hierarchy until they reach the national level. While this data collection approach is inexpensive and can provide timely data at a finer disaggregation level, research has shown that it is prone to large measurement errors. In 2018, Badan Pusat Statistik (Statistics Indonesia) switched to an agricultural survey approach using frame area sampling. This approach has shown a better level of accuracy but also

requires a great amount of effort and resources. In this paper, we will discuss the use of Sentinel-1 satellite imagery which is processed through Google Earth Engine to produce maps of paddy cultivation area in Indonesia, focusing specifically on the province of West Java from October 2018 through March 2019. Random forest algorithms were used for image interpretation and classification by utilizing ground truth information from the agricultural surveys using frame area sampling. The results show that the interpretation of Sentinel-1 satellite images for mapping paddy cultivation area has an accuracy of 93%. These results indicate that the use of remote sensing can be accurately and efficiently used for mapping and monitoring paddy cultivation. Another advantage of using remote sensing is that it can provide tabular and geospatial information, so it is helpful to formulate policies precisely.

**PP127: GODAN platform for better agriculture
(Abstract Id: A2-3-028)**

Kakha Nadiradze
Green Technologies , AFRD, Tbilisi , Georgia
nadiradzekakha@gmail.com

Green and new digital innovative technologies in agriculture allows farmers, agricultural cooperatives decrease the use of chemical input harmful for the environment or offer alternatives to the use of traditional energy sources and inputs enhancing adaptation and resilience to adverse conventional agriculture to organic agriculture improving time-saving, costs, labors, and increase farmers' income. Green solutions in agriculture are important to save high competitiveness, quality and quantity of produced products, We are very encouraged to establish open data platforms from their field research and activities in order to address the complex challenges around food security and sustainability. We recognize that human well-being is dependent on healthy functioning ecosystems and the services they provide for sustainable food production, agriculture and green economy. In Georgia, ecosystems continue to be significantly reduced in extent and threatened with the loss of crucial functions. This puts ecosystem service delivery at risk. In many cases, national decision-making processes do not take full account of the value of agrobiodiversity and ecosystem services. National ecosystem assessments can deliver an evidence base that meets the needs of decision makers through a tried and tested the stakeholder engagement process. Agriculture has changed dramatically in the last five decades. Food and fiber productivity soared due to new technologies, mechanization, increased chemical use, specialization and government policies that favored maximizing production. These changes allowed fewer farmers with reduced labor demands to produce the majority of the food and fiber. Although these changes have had many positive effects and reduced many risks in farming, there have also been significant costs. Prominent among these are topsoil depletion, groundwater contamination, the decline of family farms, continued neglect of the living and working conditions for farm laborers, increasing costs of production, and the disintegration of economic and social conditions in rural communities. A growing movement has emerged during the past two decades to question the role of the agricultural establishment in promoting practices that contribute to these social problems. Today this movement for sustainable agriculture is garnering increasing support and acceptance within mainstream agriculture. Not only does sustainable agriculture address many environmental and social concerns, but it offers innovative and economically viable opportunities for growers, laborers, consumers, policymakers and many others in the entire food system. Sustainable agriculture integrates three main goals: environmental health, economic profitability, and social and economic equity. GODAN, the Global Open Data for Agriculture and Nutrition initiative advocates proactive sharing of open data to make information about agriculture and nutrition available, accessible and usable. A rapidly growing initiative, the GODAN Network has over 750+ member organizations around the

world, that have committed to making information about agriculture and nutrition available to all. Partners range from national government bodies and policy-makers, non-governmental organizations, academics, research organizations, as well as private sector organizations and corporations.

PP128: Human to machine transition: Emerging trends in data collection
(Abstract Id: A2-3-027)

Sreekanth S R
School of Research and Innovation, CMR University, Bangalore, India
sreekanth.17phd@cmr.edu.in

The rapid development of information and communication technologies in the last ten years has brought in new opportunities in the field of Data Quality and Data Collection. The traditional paper-based data collection systems were highly dependent on well-trained data collectors to ensure the complexities and rigorous rules related to administering of the questionnaire. Complex skip patterns, use of advanced statistical method and sample generation when done as manual processes, require very specialised manpower. Also, we need to always add a buffer to sample size to compensate for errors in paper-based surveys. Digitising the data collected from the paper-based surveys has many challenges too. To eliminate the error that may get introduced during the digitisation processes such as double-entry validation are made use of which adds to the cost of digitisation. Also, this approach makes detection of errors more complex and many times errors are detected only during the data entry process. Such errors are not always easy to rollback or correct as the data collection source or respondent may not always be available for the recollection of data. Use of technology in Data Collection and Data Quality processes can have a significant positive impact on the quality of the data. Modern technologies enable us to set up data collection systems where skip patterns are naturally honoured, Validations are enforced based on the type of validation such as hard-validation, soft-validation or Honey-pot validation. The sample generation process can be automated to ensure sampling errors are eliminated. Certain data can be directly derived from secondary sources and may not be required to be collected explicitly. Newer technologies such as sensors and IoT devices can be used to automate the collection of certain data. Many fraudulent data collection practices of data collection agents can be eliminated by the right use of technology. This paper explores the emerging technology options in data collection and data quality assurance. The specific focus will be on the adoption of portable smart devices for data collection as a replacement to paper, use of GIS, Mobile Telephony network and Artificial Intelligence. This study is based on real-life data collection projects where such interventions were taken up and studied for intended improvements in efficiency, quality and reliability.

PP129: Primary data collection
(Abstract Id: A2-3-026)

Eromosele John
Academy, Code for Nigeria, Lagos, Nigeria,
john@codeforigeria.org

We are in the data revolution with a high influx of datasets to the internet as open data portals springs up here and there (government and private) hence data standard, data integrity and quality assurance is a concern. These concerns should be checked right from the collection process, a review of the

primary data collection process by many researchers, technologists, journalists and even students shows data loss, inaccurate data and other concerns begins from the field as a result of data collection using paper (hard copy). Technology helps us checkmate these concerns, producing a high grade data. I want to have a workshop session (50 Minutes) to showcase/train farmers/participants (even without coding skills) to build a simple data collection tool that runs on Android mobile devices without a line of code (purely drag and drop) using Open Data Kit (ODK). This tool is open source and can collect data even from the most remote location on earth where there is no internet or mobile data connection. Data collected automatically feeds to a server as soon as it gets to a network location. This tool can collect the following data types- Text, Numeric, Multi-choice, multi-media, barcode encryption and geo-coordinates. I have customized this tool to collect data of farmers and farms from the largest local government area of Edo State, Nigeria in 2015, which formed the baseline data for the ministry of Agriculture. I also used it to collect environmental data on Illegal waste dump site in Benin City for Code for Africa. I wish to be considered to impact this skill on participants and possibly support them to deploy in upcoming projects.

**PP130: Social media platforms: The future data collection channels in technology-enabled survey studies
(Abstract Id: A2-3-019)**

^aOlugbemi A. Olujimi and ^bWajdi Ben Rejeb

^aOperations, Kantar, Nigeria, Ikeja, Lagos, Nigeria

^bBusiness Management, University of Roehampton London - Laureate
Online Education, National Institute of Applied Sciences & Technology,
Tunis, Tunisia

olugbemijimi@yahoo.com, wajdi.benrejeb@roehampton-online.ac.uk

This study investigates the use of social media platforms as alternate tools for data collection in Nigerian marketing research and other survey studies using different four social media platforms (Facebook, Twitter, Skype and WhatsApp) and the paper-based questionnaire as the control. The ANOVA and Duncan's test carried out on the responses from the leading data collection platforms experimented showed them not to be significantly different with $P > 0.05$. The same result was also obtained from the various cross analysis performed on the survey data. This implied that within the limits of this experimentation, social media platforms produced relevant alternatives for the data collection on survey studies as the traditional paper questionnaire. Furthermore, the study also revealed a significant difference with $P < 0.05$ on preference level for the future online social networking for marketing research and survey studies with the greater number of respondents preferring online networking for marketing research purposes in the future especially through WhatsApp and Facebook.

**PP131: The use of Excel for the design, collection and processing of data; As an alternative to classical methods
(Abstract Id: A2-3-018)**

M'hamed Tifouri

Agricultural Statistics and Information Systems Directorate, Ministry of
Agriculture, Rural Development and Fisheries, Algiers, Algeria

The design, conduct and processing of statistical operations requires the use of data carriers, sometimes conventional, paper-based, and sometimes using different levels of recourse to new technologies. Each method has its own advantages but also disadvantages. Data collection is a crucial step. Too often, the cost, time and level of difficulty associated with this step are underestimated. We have to be fully aware of it. There is the initial data collection to do the initial analysis and the recurrent data collection, which will feed a dashboard for example, once it is in place. This data collection should be, as much as possible, automated, to facilitate the process. On the occasion of the presentation, it will be projected to the assistance, a method based on the use of the Excel tool of Microsoft, with a minimum of knowledge in VBA (Visual Basic) to carry out the following operations : - Questionnaire design; - Generation of locked questionnaires, with pre-filling of data; - Group sending of questionnaires (mailing list using Thunderbird and the MailMerge extension); - Direct filling of questionnaires, with predefined printing areas; - Automatic import of data entered; - Instant treatment ; - Backup of raw data. The last part will discuss the advantages of this method as well as recommendations from the experience of Algeria in the use of this method.

PP132: Updating geospatial data for sustainable coastal agriculture in Bangladesh
(Abstract Id: A2-3-022)

^aMd Rafiqul Islam, ^bMd Giashuddin Miah and ^bTofayel Ahamed

^aDepartment of Agronomy, Bangabandhu Sheikh Mujibur Rahman
Agricultural University, Gazipur, Bangladesh

^bDepartment of Agroforestry and Environment, Bangabandhu Sheikh
Mujibur Rahman Agricultural University, Gazipur, Bangladesh
rafiarib@yahoo.com, giash1960@gmail.com, tofayela@gmail.com

The coastal agricultural resources are highly vulnerable to many adverse ecological processes. Various natural and anthropogenic activities are the major threats of coastal resources. Shrinking agricultural land and various production pressures also tend to increase coastal resource degradation. The coastal resources are very dynamic, diverse and competitive. These imply that the spatial and temporal information of the agricultural resources is imperative for effective management and planning of the coastal agricultural resources. To address this, various strategic development plans are generally prepared based on data available through direct or indirect information sources like survey reports, monitoring, expert consultations, and workshops. Those data could not be effective possibly due to the application of laborious and lengthy scientific processes, and irregularity in data collection. For instance, land and soil resource database is much rich in Bangladesh, and the country already completed a semi- detailed soil survey using aerial photographs followed by cartographic mapping. However, it required several decades to complete the survey with occasional updating. It seems that data-updating processes are much slower, and mostly lost their utility when data are available to the stakeholders. For example, data available on crops, hydrology, land and soils, settlement of the coastal region were estimated through the aerial photographic survey in the 1980s and 1990s but recent data are not available. Satellite data are now available at different resolution and free of cost, which can be potentially used for updating those data. On this background, this paper highlights the usefulness of satellite data and integration of those data with existing database and change analysis of resources in the coastal area of Bangladesh. Therefore, we investigated the long-term change (1989-2010-2018 periods) of coastal agricultural land and soil resources using geospatial technology and generated various geospatial maps and data on geomorphology, soils, hydrology, the intensity of land use changes and intrusion of salinity, and development of resource-based cropping systems in different

agro-ecological regions. Satellite image analysis showed that the increase of settlement area was 6825 ha per year during 1989-2010 and 14125 ha during 2010-2018. This estimation indicates that a huge amount of agricultural land has been transformed into other uses, which are most alarming for sustainable agricultural production in the future. Similarly, the changes of various land use and land cover including croplands, mangrove forest, shrimp cultivation, land erosion-accretion were estimated and updated. Such temporal and spatial data and change detection may be useful for making a decision for sustainable use of the coastal resources. The approach adopted in the study could be useful for updating agricultural resources in many vulnerable coastal ecosystems in the world.

**PP133: Satellite night light data for predicting developmental indicators in India
(Abstract Id: A2-3-021)**

Subash Surendran Padmaja and Aditya K.S
Agricultural Growth and Development, ICAR-National Institute of
Agricultural Economics and Policy Research, New Delhi, India
Division of Agricultural Economics, ICAR-Indian Agricultural Research
Institute, New Delhi, India,
subashspar@gmail.com, adityaag68@gmail.com

Availability of data is a key constraint limiting assessment of development-oriented programs in developing countries. In this paper, we explore predicting rural development indicators using satellite night light data. We used an open-access satellite night light data; 'India Lights API', provided by University of Michigan based on satellite images of Defense Meteorological Satellite Program (DMSP), of the U.S. Department of Defense. The data constitutes ground level luminosity measure of about for 6,00,000 villages for a period of 20 years (from 1993 to 2013). We used district-level estimations to predict developmental indicators. We employed both statistical models and machine learning models to predict development indicators. The study shows that most of the machine learning models, but not all, showed stronger predictive power than standard econometric approaches. The study demonstrates the power of machine learning techniques and applications in settings where data is limited. We also discussed the scope and efficacy of such publicly available data to produce development indicators.

**PP134: Will artificial intelligence become a necessity in agricultural practices?
(Abstract Id: A2-3-029)**

Sahil Verma
Computer Science, National Institute of Technology, Kurukshetra, India
vsahil98@outlook.com

According to the World Counts 2018 statistics, more than 1 billion people suffer from hunger and 36 million will die of malnourishment. The human population is expected to grow by 47.36% by 2100 and FAO estimates the world has lost 33% of its arable land in the past 40 years and currently 11% of land surface is used for crop production. To keep up with human population growth, the quantity of food produced over the next 50 years would have to be more than the quantity of food produced in the last 10,000 years combined experts claim. Humans may be on a brink of a crisis which may be solved by implementing frontier technology in agriculture. This implementation may take various forms;

predicting weather by Artificial Intelligence which would reduce inaccurate weather forecasts hence enabling farmers to pick optimal days for farming and harvesting. Artificial Intelligence could be used to detect abnormalities in crops hence preventing situations like the Black Stem Rust in 2007. This has been implemented by a team using TensorFlow, a Google's open source library which can be used by an app making it highly accessible to poor farmers. Precision Farming is considered the new way of agriculture which combines AI and IoT to collect data, analyse it and act accordingly. Microsoft FarmBeats is a data driven farming project designed to help increase farm productivity and reduce costs. Ground sensors measure inputs such as soil moisture and nutrients etc. Drones are used to help farmers map their fields, monitor crop canopy remotely, and check for anomalies. This approach has significantly increased the quantity and quality of the crops produced in the same land area reducing the agricultural waste. It may seem that the reason for hunger is the limited quantity of food grown which is far from the truth. Hunger is caused by poverty and inequality, not scarcity. The agricultural produce is currently 150%, enough food to feed everyone on the planet i.e. 10 billion people can be fed currently which is the expected population in the year 2050. The real problem is not whether we can produce more food, rather how to make the distribution process more efficient. Moreover, the introduction of frontier technology to agriculture would reduce the demand of unskilled labour and most of the farmers in developing countries are uneducated which may hinder new possibilities. To conclude, frontier technology brings with it many promises; we can prevent destruction of a large quantity of crops (30 - 40% of crops grown are destroyed). However, currently we have enough food grown to feed 150% of the current population and the rate of growth of agriculture produce is faster than the rate of growth of human population. Technology can temporarily solve this crisis and may positively affect the rural youth directly by creating another reason to attend school which directly correlates to a decrease in poverty. However, an efficient food distribution system must be put into place as to provide a long-term solution.

**PP135: A case study on improving the consistency and traceability of IATI data
(Abstract Id: A2-4-012)**

Brian Carisma and Silvia Missiroli
Statistics Division, Food and Agriculture Organization, Rome, Italy
Brian.Carisma@fao.org, Silvia.Missiroli@fao.org

Ensuring the availability of quality data on aid flows is crucial to understand and address resource gaps in pursuing the SDGs. The global initiative that promoted transparency in the records of aid data flows, the International Aid Transparency Initiative (IATI), has come a long way 10 years after it was launched with over 950 publishers to date. As the number of organizations reporting to IATI has increased considerably, concerns about the quality of data reported are becoming evident. Such concerns may prevent an effective use of the data. Organizations are responsible for deciding how much detail they provide on their activities, and IATI does not audit or verify the data. It is expected that organizations continually improve the range and quality of their data reported to IATI. The fundamental value of IATI is to report timely, reliable and forward-looking data on aid flows, their direction, and their purpose. While reporting these basic information seem straightforward, actual reports of aid donors and recipients for funded projects may differ considerably, owing to subjective interpretation of the “purpose” of the activity, of geography, and the variability in the description of projects. Inconsistent reports may lead to double-counting of projects, and the generation of “non-existent” flows directed to different sectors. The proposed case study examines the consistency and traceability of a sample of funded projects published in IATI by the Bill and Melinda Gates Foundation (BGMF), a donor, and the Food and Agriculture Organization (FAO), which is in this

case an aid recipient and an implementing agency. The study employs an SDG Fitness-for-use framework in which reported aid flows are compared and evaluated according to 4 common elements; the sector/purpose, recipient/ geography, coverage notes (description) and policy markers. These elements are the most common queries for extracting aid flow information. Results highlight the similarities and differences among funded projects reported in IATI, and allow examining the reasons of differences from the perspectives of aid donors and recipients. The study will also presents options for improving the consistency of IATI reports, notably the benefits of agreed common elements to be reported to IATI during the project inception. It also recommends promoting a traceability mechanism for funded projects based on the experience of BGMF and FAO, which would satisfy the reporting requirements of both parties.

**PP136: Using new tools to make metadata of agricultural survey more quality
and available for data users
(Abstract Id: A2-4-008)**

Waleed Mohammed
The sustainable development Unit, Central Agency for Public
Mobilization and Statistics, Cairo, Egypt
kant2012xp@hotmail.com

Egypt's agriculture sector remains one of the most productive in the world, despite the small percentage of arable land, irregular and insufficient water supplies and problems with waterlogged and highly salinated soil. , So Reliable and timely information on agriculture statistics such as crop area, crop production and land use is great importance to planners and policy makers for efficient agricultural development and for taking decisions on procurement, storage, public distribution, export, import and for taking decisions on procurement, storage, public distribution, export, import and many other related issues. So the National Statistical Office (NSO) at Egypt is committed towards producing high quality and relevant statistical information in the agriculture field by following the principles of neutrality, objectivity, professional independence, rationality and confidentiality, and by using the following tools: 1. The Micro data Management Toolkit: that tool is developed by the World Bank Data Group for the International Household Survey Network (IHSN) is designed to address the technical issues facing data producers and make metadata is available for data users. 2. Summary quality report (SQR): the SQR provides users with both quantitative and qualitative information based on European standards. The reports also contain a summary of methods and explain areas where caution in interpretation may be required, structured around the European Dimensions of Quality, in general the objective of this reports is to help users understand our statistics and to use them appropriately. 3. Lunching the Egypt SDG Observatory for raising statistical awareness with all indicators including agriculture indicators. Based on the above this paper will discuss the above-mentioned tools as a tool for Quality reporting on agriculture statistics from the prospective of NSO experience's at Egypt to show its importance in the quality and availability of agricultural data to users.

**PP137: Municipal administrative data for statistical purposes
(Abstract Id: A2-4-009)**

Pablo Mauricio Moscoso Ontiveros
Censuses and surveys, Statistics National Institute, Cochabamba, Bolivia

In the present research work, the importance of municipal administrative data as a source of data collection for statistical purposes is disclosed. To this end, a characterization questionnaire of the administrative data was prepared to know the current status of the same. The municipal plans and programs were analyzed and a bibliographic review of the legal framework of the competences of the municipalities was carried out. The production of administrative data is highly relevant for the collection of information, considering the comparative advantages they have over other types of statistical processes. In addition, in coordination and collaboration with other institutions, the administrative data present the opportunity and possibility of being transformed into statistics, for the generation of public policies of the different instances. The vision that is taken from the analysis carried out is to make a later study of the administrative data as an instrument of data collection to generate the same statistical information obtained with the censuses.

PP138: Improving data dissemination through involvement of stakeholders in gathering, visualizing and analyzing data using participatory GIS and participatory modelling software
(Abstract Id: A3-5-024)

^aNagesh Kolagani, ^aRavi Gorripati, ^bAtanu Deb, ^cPavan Matham and ^cD N Rao

^aComputer Science and Engineering, Centurion University of Technology and Management, Odisha, India

^bAgriculture, Centurion University of Technology and Management, Odisha, India

^cManagement, Centurion University of Technology and Management, Odisha, India

nagesh.kolagani@alumni.iitm.ac.in, ravi.g@iiits.in,
atanudev@cutm.ac.in, pavanwsn@gmail.com, dnrao@cutm.ac.in

Dissemination of data among stakeholders can be facilitated by: 1) Involving them in gathering data and improving their trust in it, 2) Making it easier for them to visualize and understand it better, and 3) Involving them in its analysis and modelling. Such a process is being adopted successfully to promote organic farming in a south Indian village as part of an ongoing project (<http://apzbnf.in/>). For gathering detailed data about wells, farms and households in the village over last few decades, a mobile and desktop open source participatory GIS (P-GIS) software was developed. It was designed to be extremely easy-to-use even by middle school children and by those with low levels of literacy. School children and youth gathered desired data using its mobile application module and prepared maps from the data for use by their elders using the desktop GIS module. The software was made highly customizable to local social, environmental and other requirements so that local resource persons with no-prior programming experience could customize GIS layers within the software to meet their location-specific requirements. The software was designed to be easily adaptable by these local resource persons to display in any desired language using graphics. It was designed to function even in regions with low or no network connectivity without any loss of data or functionality. To improve data visualization and understanding, the software was designed to handle simple pre-defined scenarios conceived by local resource persons. Using these location-specific custom scenarios, diverse groups of stakeholders with various levels of skills could perform 'what-if' scenario analysis most

appropriate to their needs with little technical support from outsiders. For incorporating stakeholder knowledge into the data modelling process, 'system dynamics', a simplified participatory modelling method, especially its causal loop diagram tool, was used extensively. Farmers carried out detailed participatory accounting of: water, crop and household economics over last few decades and understood that future of agriculture in their village lied in reviving rainfed organic farming practices.

**PP139: Integrated database system for ground water resources
(Abstract Id: A3-5-017)**

^aShbana Begam, ^bRajni Jain, ^cS.K. Srivastava, ^aAlka Arora and ^aSudeep
Marwaha

^aComputer Application, IASRI, New Delhi, India

^bComputer Application, NIAP, New Delhi, India

^cAgriculture Economics, NIAP, New Delhi, India

shaba.shb@gmail.com, Rajni.jain@icar.gov.in,
sk.srivastava@icar.gov.in, alka.arora@icar.gov.in,
sudeep.marwaha@icar.gov.in

Agriculture assumes a crucial part of India's economy. Over 58 percent of the rural households depend on agriculture as their principal means of livelihood. As per the year 2018-19, agriculture, along with forestry and fisheries contribute 15.87% to the Gross Domestic Product (GDP). To nourish the constantly expanding population of our nation, sustainable development in agriculture production is exceptionally important. Crop production is exceedingly reliant on irrigation water. Groundwater assumes an essential part in agricultural development by upgrading the efficiency of inputs and by providing guaranteed irrigation to the farmers. Groundwater resources data available from the different sources in different formats, such as water level data available from Directorate of water management but in PDF format, aquifer properties data published from CGWB in text format, availability and draft used data published from Directorate of groundwater management in the form of observation well wise at the state level. An integrated groundwater database aims for (i) providing range of groundwater information by transforming the heterogeneous data in to homogenous format, (ii) analysis of information on groundwater resources and sharing among stakeholders, (iii) maintaining the nationally consistent data on groundwater from authorized sources, (iv) taking better informed decisions to manage vital groundwater resources, and (v) providing timely and accurate information on various aspects of groundwater. Such an integrated database should be able to provide data at the micro level because aquifer properties of groundwater vary at a micro level based on measurements from an observation well. The Entity- Relationship (E-R) diagram represents the database in terms of objects called entity and relationship among them. A well-designed ER diagram facilitates storage and management of macro to micro-level data. Further, a web-based groundwater database system was developed using the integrated database to display various useful reports like groundwater level at a place, groundwater development status, aquifer properties, poor quality area, and groundwater related schemes. This system presents information about various aspects of groundwater resources at various levels like state wise, district wise, year wise and cluster-wise to various stakeholders as per their needs. Report on the status of groundwater gives the information on available groundwater, drafted groundwater and groundwater development index for a selected year. Report on water level gives the water table depth for pre-monsoon and post-monsoon at the selected

place for a selected year. Report on aquifer properties shows discharge and drawdown properties of the selected place. Discharge means how many liters of water comes out from a pump in per second whereas drawdown means how many meter water level goes down during pumping. Report on poor quality groundwater specifies the areas having a poor quality of groundwater as decided by Central Groundwater Board. Report on groundwater schemes for the selected state will be useful for farmers to get knowledge about irrigation related schemes from the Government.

PP140: Big data and big opportunities to improving household surveys in Egyptian statistical office
(Abstract Id: A3-5-016)

Haidy Mahmoud
President office, CAPMAS, Cairo, Egypt
haidy_samy2015@yahoo.com

This paper aims to improving the quality of statistical products in Egypt through to examine the impact of applying the total quality standards on household surveys, focusing on "the income, expenditure and consumption survey" as one of the most important field surveys carried out by statistical agencies worldwide, True to the life of the Egyptian citizen. The study used descriptive analytical and quantitative statistical methods, based on the evaluation of the statistical status of Egypt, the European code of best practices, evaluation of experts and citizens on the quality of statistical data, the use of the statistical capacity index as a good means of comparing the performance of the Egyptian statistical apparatus with its counterparts in the Arab, African and international countries. In Egypt, in addition to the SWOT analysis. Statistical methods were used to identify the correlation between the various variables. The study results showed that the standard (accuracy) is the most affect by 38% correlated with the other quality standards; then the (availability) is 21%; that both the standard (accuracy) and (availability) affect 59% on the quality of the output of the statistical product, It was also found that 99% of the sample frame design affects the quality of the statistical product, 61% of the response rates in the field work are due to the accuracy and clarity of the statistical form used in the data collection form, only 7% of the researcher's training on the data collection form affects the fieldwork method, it was found that 55% of the analysis of the survey results is due to the accuracy of published data.

PP141: Nowcasting the Italian unemployment rate with google trends
(Abstract Id: A3-5-005)

^aAndrea Fasulo, ^bAlessia Naccarato and ^bAlessio Pizzichini
^aPopulation census, ISTAT, Rome, Italy
^bEconomic, Univeristà degli studi Roma 3, Rome, Italy
alessia.naccarato@uniroma3.it, alessiopizzichini@gmail.com

The Italian National Institute of Statistics, as well as most of the National Statistical Institutes in the world, produces forecasts of socio-economic indicators by means of statistical models that make no use of information from external sources and rely only the data provided by its own sample survey. In the field of Official Statistics, some studies have recently been conducted to assess whether online search data can be used to facilitate the estimation of phenomena of interest or to produce additional information, starting from data such as internet search data, whose main features are easy availability

and low cost. Several studies have used the Google Trends (GT) time series for the nowcast of important short-term economic indicators. One of the most studied is the unemployment rate and specifically many studies have focused on the prediction of the youth unemployment rate because it is assumed that these use more than the others the online job search channel. The paper tries to verify this hypothesis by comparing different models for the nowcast of the quarterly unemployment rate for different age categories, specifically 15-24, 25-34 and 35-49. The results show that for each age category analyzed the best nowcast predictions are always those provided by the ARIMA model in which the exogenous variable is the GT query share. The results obtained also showed that the age category that has the greatest prediction improvements is the 25-34. Although Google Trends data can generally be found at very low cost and in a short time, there are some aspects of the use of data processing in GT that cannot be overlooked. Among these, one of the most important is the choice of keywords to be used for the selection of data sets. Different keywords lead to different results; however, if the selection criterion derives from an adequate knowledge of the phenomenon under examination and by performing checks on a large number of keywords and their recurrence, it is possible to obtain useful results. For this reason, the paper presents a final analysis aimed at studying the volatility of the time series provided by GT. The results show critical issues in terms of high variability for the GT time series, questioning the use of them for the production of Official Statistics.

**PP142: Prescriptive modelling of crop yields using neural networks and
multivariate linear regression: case study of paddy crop
(Abstract Id: A3-5-022)**

^aSuman Sengupta, ^aRamana Lingampally, ^aNagesh Kolagani and ^bD N
Rao

^aComputer Science and Engineering, Centurion University of Technology
and Management, Odisha, India

^bManagement, Centurion University of Technology and Management,
Odisha, India

Low crop yields is a major problem in several district of India. It is substantially due to lack of precise knowledge among farmers about what inputs to give in what quantities. Since these input requirements depend on several conditions such as previous crop, soil nutrients, etc., it is not easy to train the farmers in calculating these quantities. Hence they follow rough thumb rules resulting in low yields. Current study plans to address this issue by: i) Predicting crop yield given input quantities, ii) Building a proof-of-concept model and a mobile application incorporating this model, and iii) Allowing farmers to use this application to analyze various input scenarios and choose the best input-output combination. To do this, we built a supervised machine learning model using neural networks and multivariate linear regression algorithms to predict paddy yield, based on data gathered from thousands of farmers using another data gathering mobile application. In this way, we built a self improving predictive system to help the farmers. Trials were carried out for Paddy crop by gathering data from 3,500 farm plots about crop yield and 64 cultivation inputs such as seed variety, fertilizers, farm yard manure, etc. These plots were selected using stratified sampling from various types of farm plots. The data was cleaned for missing values, outliers, etc., and about 1,100 clean records remained. Both neural networks and multivariate linear regression algorithms were carried out to identify critical inputs that had a statistically significant influence on Paddy crop yield. The model coefficients were stored in the mobile application and a linear maximization algorithm was written for prediction of input quantities to maximize output. By using this application, farmers will have access to the intelligence gathered from thousands of farmers over years at their fingertips. They are able to take

well guided decisions regarding what inputs are required to maximize yield. In case a particular input is not available in prescribed quantity, the farmer also gets a clear estimate of the impact on resulting drop in yield.

**PP143: Role of artificial intelligence in market intelligence system
(Abstract Id: A3-5-025)**

Abimanyu Jhahhria, Shiv Kumar and Kingsly Immanuelraj T
ICAR-National Institute of Agricultural Economics and Policy Research,
New Delhi, India abhimanyu.jhahhria@icar.gov.in,
Shiv.kumar6@icar.gov.in, k.immanuelraj@icar.gov.in

The Indian agriculture is undergoing a lot of transformations such as increasing commercialization, diversification towards high-value commodities, liberalization and global interfaces, increase in foreign direct investments, etc. Several institutional and policy initiatives have been taken to support these transformations. However, prices of agricultural commodities play a dominant role in farm profitability and distribution of income. The prices of food and agricultural commodity in India are primarily determined by domestic market forces along with the domestic price policy. In recent years, agricultural prices have suffered from very high volatility. The volatility in agricultural prices has a catastrophic effect on all stakeholders. Considering the fluctuations in agricultural price scenario, a proper understanding of agricultural price mechanism and their forecasts would help all stakeholders in the agriculture. Market Intelligence is the process of collecting relevant information related to the existing market prices, domestic and global agricultural supply, and demand conditions, policy environment and other relevant factors; converting these into usable form through scientific modelling and stakeholders' perceptions; and disseminating precise information through effective means so that informed and effective decisions can be taken by the farmers and other stakeholders. Reliable forecasting is extremely important for efficient planning and decision making. Time series models have become increasingly popular as a tool to describe such economic phenomena. The most popular and widely used time-series model has been the Box-Jenkins Autoregressive Integrated Moving Average (ARIMA) model. Univariate ARIMA models use only the information contained in the series itself. Later, it was observed that the ARIMA family has serious limitations and is not capable of modeling the datasets that depict volatility. Considering this, Engle (1982) proposed the Autoregressive Conditional Heteroscedastic (ARCH) families of parametric nonlinear time-series models. It captures the volatility in prices through inbuilt modeling mechanisms. More recently, Artificial Neural Networks (ANN) have been studied as an alternative to these non-linear model-driven approaches. ANN belongs to the data-driven approach, i.e. the analysis depends on the available data, with little a priori rationalization about relationships between variables and about the models. Conventional software programs are hard-coded by humans with specific instructions on the tasks they need to execute. By contrast, it is possible to create algorithms that "learn" from data. Artificial Intelligence is a program that can adapt itself to execute tasks in real time situations using cognitive processing as the human mind. Through Big Data and IoTs, use of AI has become viable as vast quantities of data and unprecedented processing power are available. Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. The work activities currently performed by people in market intelligence could potentially be automated through machine learning.

PP144: Climate resilient, high yielding and stable sugarcane genotypes in India

(Abstract Id: A4-6-031)

^aRajesh Kumar and ^bA.D. Pathak

^aAgricultural Knowledge Management Unit , ICAR - Indian Institute of Sugarcane Research,, Lucknow, India,

^bICAR - Indian Institute of Sugarcane Research, Lucknow, India
rajesh_iisr@hotmail.com, pathakashwini@rediffmail.com

India by contributing 19.08% area and 18.18% production ranks second among sugarcane growing countries of the world for both area and production of sugarcane (Kumar et al. 2015). In fact, sugar manufacturing is the second largest agro-based processing industry in our country. The turnover of the sugarcane, sugar and other related economic activities were approximately of Rs. 104.104 thousand crores per annum during 2014- 15 at constant price, out of which, nearly Rs. 55-60 thousand crores is paid to the sugarcane farmers by the sugar mill as prices for its supply. It is estimated that about 5.568 million sugarcane cultivators/farmers and 6.769 sugarcane laborers (total of about 12.337 million sugarcane workers) are engaged in the cultivation of sugarcane in India, which accounts of 1.427 % of total rural population of India. Out of 6.26 million sugarcane land holdings of the country, 82.82 % are marginal (less than 1.0 ha) and small (1.0 to 2.0 ha) which occupies nearly 54.44 % sugarcane area. Five lakhs skilled and unskilled workers including highly qualified and trained technologists are engaged in the manufacturing of sugar. The sugarcane is one of the most important than the other crops (paddy, wheat and cotton) as it is more remunerative. Being a long duration crop, sugarcane cultivation is challenged by large number of biotic and abiotic stresses in one or other stages of its growth. Major abiotic stresses are high temperature, drought, water logging in some part of the country, cold and salinity. Evolving resistance or tolerance varieties combined with high yield and high quality has been the main focus of sugarcane improvement. Based on long term data analysis of advanced varietal trails of All India Coordinated Research Project (AICRP) on Sugarcane, identified nine genotypes which possess the qualities of high yield sustainability and low sensitivity towards adverse changes in environmental conditions during 2012 to 2018. Out of nine, two Co 10024 and Co 11001 from early group and two CoM 11086 and Co 08009 from midlate group of Peninsular Zone. In East Coast Zone, only one early maturing genotype, CoA 13322, was identified. Two mid-late genotypes, CoH 08262 and CoH 09264, were identified from North West Zone. Similarly two mid-late genotypes, CoSe 11454, CoP 12438, were identified from North Central and North Eastern Zone. Out of 163 genotypes, only CoSe 11454 was highly stable for all the three character, CCS (t/ha), cane yield (t/ha) and sucrose (%). Other eight were highly stable for CCS (t/ha) and cane yield (t/ha) only. These may be used as parents in crossing programme as possess the qualities of high yield sustainability and low sensitivity towards adverse changes in environmental conditions or having high stability and high yield criteria. Climate change induced changes in growth and development and adverse effects on sugarcane and sugar productivity invoke in urgency for climate – resilient varieties of sugarcane to mitigate such effects. Bakshi Ram (2018) highlighted that breeding for drought tolerance is yet to go a long way to yield desired results. The wild species *S. spontaneum* as source of biotic and abiotic stresses has been utilized to the maximum extent. Presently we are focusing on other wild species like *E. arundinaceus* and *E. procerus* in the pre-breeding programme as source of resistance to drought and water use efficiency.

PP145: Comparative study of cost of production in permanent crops in Nepal
(Abstract Id: A3-5-019)

Shiv Narayan Mahato

Introduction Fruit planting in major agriculture sector for farming. How much cost is needed and how much output will get in the permanent crop farming sector is needed for this agriculture activities. This data will also help to national account session. For this objective, Central Bureau of statistics conduct "Permanent Fruit Cost Survey 2074 BS. In this survey it include major permanent crops of Nepal they are Mango, Banana, Orange and Apple. This survey result cost of permanent crop farming, National Account Session for calculate GDP and the policy making for permanent crop farming and pocket area for that plan. Sample Design Four potential fruits of Nepal: □ Apple, Mandarin, Mango & Banana were selected for CoP. □ It was decided to take total 507 sample farmers. □ Sample size allocation: power allocation with 0.5. □ At least 1/3 of potential districts were selected for each fruits. Number of samples were allocated to districts by proportional to their Areas. □ Fruits garden of each district must represent all Age groups. For mango 16 districts of tarai were selected in sample for banana 13 districts of tarai were selected in sample for orange 16 districts of hill were selected in sample for apple 10 districts of mountain and hill were selected in sample Results There is significant difference in output input ratio and profit/loss ratio among these permanent crops mango, banana, orange and apples. Permanent crops plant per ht. Labour per ht. Material per Ht. rate per qtl. yield rate qtl. / ht. yield rate Rs. / ht. profit/loss/ Ht. output input ratio Benifit cost ratio Mango 120 33903 26874 3014.16 84.2 253792.27 174202 3.19 2.2 Banana 1952 36890 48306 1737 119.2 207050.40 54040 1.35 0.35 orange 344 5939152827 4567 85.37 389884.79 222078 2.32 1.32 Apple 344 44980 23023 2834 60.1 170323.40 170174 1.6 0.6 The study showed that the yield rate qtl. of mango, banana, orange and apples per hector is 84.2, 119.2, 85.37 and 60.1. Similarly, the yield rate Rs. per Ht. of mango, banana, orange and apples is 253,792.3, 207,050.4, 389,884.8 and 170,323. 4 respectively. Also the output input ratio of mango is highest and for banana is lowest. Similarly, the profit loss ratio of orange is highest and for the banana is lowest. The results show that Orange and mango give more output than banana and apple. Conclusion The permanent crop give more output in tarai and orange give the more output in hill and mountain area . So the government of Nepal should prefer to the farmers for planting them.

PP146: Cultivation of stone fruits in Uttarakhand: Market accessibility of farmers and monopsonist behaviour of intermediaries
(Abstract Id: A4-6-062)

Taniya Sah
Humanities and social sciences, Indian Institute of Technology, Delhi,
New Delhi, India,
tiasah2@gmail.com

Food production in India has increased manifold from 51 million tonnes in 1950-51 to about 252 million tonnes in 2014-15. However, farm income has not grown in the same proportion, as the Situation Assessment Survey (2003,2013) of farmers' data reveal. Average annual income of the farmer household was Rs 25,380 in 2003 and only about Rs 101 a day during 2011-12. In this paper, I focus on two important supply-side factors responsible for farmers' exploitation- dependence on intermediaries, and lack of market accessibility due to poor infrastructure. I analyse the supply chain of stone-fruits in Uttarakhand, a hill state in northern India. Uttarakhand is the leading producer of stone-fruits (peach, plum, apricot and pear among others) in India. I use a novel dataset constructed by doing a primary survey in Nainital district of Uttarakhand, done using multi-stage stratified random sampling. The data has been collected by interviewing 200 farmers spanning across 20 villages of two

different blocks. Traders in the markets, transporters and other actors in the supply chain have also been interviewed. My main objective is to trace the supply chain of stone- fruits and analyse the distribution of profits along this chain, while accounting for the topography of the hills and how it affects farmers' incomes and dependence on intermediaries. In this paper, I focus on the primary actors of the supply chain- the farmers. My study finds that escalation in post- harvest (marketing) cost coupled with poor infrastructure and information asymmetry helps the traders in wielding power over the farmers. Rich farmers fare relatively well as compared to their poor counterparts, characterised by smaller landholdings. This is primarily due to their dependence on the traders for credit- both for agricultural and non-agricultural purposes. Small farmers enter into informal contracts with the traders who provide them with help- both in cash (for agricultural activities as well as for functions like marriages) and in-kind (in the form of agricultural inputs like fertilizers, pesticides, wooden planks for packing the fruits, or in the form of ration to feed the family during slack season). In lieu of this, farmers are bound to sell their harvest to the traders. Also, because these traders deal in bulk and help the farmers dispense-off their produce quickly in the absence of storage amenities, farmers prefer to deal with them over government procurers or non-government organisations that specialise in agro-processing, even if this implies additional cost in the form of the commissions of traders and transporters. There are important policy implications of the findings- an urgent need to develop storage and food-processing infrastructure that will be as helpful to the farmers as the roads that help in improving market accessibility. Also, the paper suggests that mere ICT tools such as cell phones can do little to increase farmers' profits, if not done in conjunction with an improvement in credit-lending and agricultural marketing institutions.

**PP147: Food security in Zimbabwe: A household expenditure survey
(Abstract Id: A5-7-007)**

Stein Masunda
Agriculture Economics and Development, Midlands State University,
Gweru, Zimbabwe
smasunda@outlook.com

Food security is an important issue in Africa and Zimbabwe in particular. The country's recent experience with cyclone Idai coupled with a surge in prices have left a number of people vulnerable to hunger and become food insecure. Understanding the impact of cyclone idai and escalating prices on the immediate and future food security and the most appropriate responses to address both transient (acute) food insecurity and long term chronic food insecurity through recognizing and supporting household coping mechanisms is fundamental for development. Food security is a major development problem across the globe which has the potential of undermining people's health, productivity and often their survival. The notion of food security can well be understood at household and international levels. The availability of food at a global level is not a major concern in this case, but access to food by specific individual is more critical and a major concern in some parts of the country. Food security is based on three important pillars: accessibility, availability and utilization. A household or community is considered food secure when all members at all times have physical and economic access to buy, produce, obtain or consume sufficient, safe and nutritious food to meet their dietary needs and food preferences for a healthy and active life. The outbreak of natural disasters and other whims of economic problems puts countries at the challenge of attaining tone of the sustainable development goals (Goal-2) of no hunger. The efforts to overcome the development challenges posed by food insecurity begins with the accurate measurement of the key indicators at the household level. This is due to the fact that the identification of household behaviours relating to food access serves as

a critical building block for the development of policies and programs for helping vulnerable populations, the effective targeting of assistance and the evaluation of the impact. Technically, before policies are crafted to reduce poverty and food insecurity, issues of measuring the levels of food security are core. Food access is the way different people can obtain the available food.

Normally food is accessed through a combination of home production, stocks, purchases, barter, gifts, borrowing or food aid. Food access is ensured when communities and households and all individuals within them have adequate resources such as money, to obtain appropriate foods for a nutritious diet. Access depends on income available to the household, on the distribution of income within the household and on the price of foods. The purpose of this study is to assess the level of food security in Zimbabwe using the household expenditure survey. Essentially the study seeks to understand the severity of food insecurity levels of people and its determinants. Further, this assessment seeks to predict the duration of the food insecurity period.

**PP148: How farm household spends their non-farm incomes in rural India? Evidence from longitudinal data
(Abstract Id: A5-7-006)**

Zeeshan
Department of Economics and Finance, BITS Pilani, Pilani Campus,
Jhunjhunu, Rajasthan, India
mohdzeeshan70@gmail.com

Livelihood diversification and higher non-farm incomes are viewed as a helpful mechanism to stimulate growth, reduce rural poverty and increase farm income in developing nations. However, less is known about its implications for dietary and expenditure diversity. With a nationally representative longitudinal data of farm households of rural India, this article contributes to the literature by investigating whether additional income obtained from rural non-farm enterprises (NFEs) helps farm households in enhancing their dietary and expenditure diversity. Additionally, it investigates the impact of NFEs income on farm investment to comprehend how NFEs income competes or complements with agricultural production activities. We discuss the theoretical conditions where access to NFEs income may affect farm investment, dietary and expenditure diversity in a farm household model followed by panel data analysis. The issue of potential endogeneity associated with NFEs income is overcome by using over-identified instrumental variable strategy. Socio-economic and demographic factors, agroecological zones, and household structures are included in the models as control variables. The present study finds that NFEs income significantly increased the food intake in general and it also helps farm households to shift from less nutritional to high nutritional food which contribute to greater household dietary diversity, and, it also raises expenditure on non-food items and durable household assets, resulting in greater household expenditure diversity. In addition, we have also observed that NFEs income has a positive impact on farm investment which contributes to an efficiency gain with access to NFEs income. Findings provide insights into how farm households increasingly engage in rural non-farm enterprises. This has significant policy implications for livelihood diversification and diversification in consumption expenditures, particularly for marginal and small farm households.

PP149: Impact of changes in investment and export in the education sector on agricultural productivity and growth in Nigeria

(Abstract Id: A4-6-010)

^aAgatha Oseghale, ^aAbigail Jirgi, ^bJacob Tsado, ^aRamatu Bako,
^aAlexander Coker, ^aFaith Ibrahim, ^aHalima Sallawu, ^aUsman Mohammed,
^aEzekiel Yisa, ^bSafiya Jibrin, ^aJob Nmadu and ^aKpotun Baba
^aAgricultural Economics and Farm Management, Federal University of
Technology Minna, Niger State, Nigeria
^bAgricultural Extension and Rural Development, Federal University of
Technology Minna, Niger State, Nigeria
itodine.agatha@futminna.edu.ng, abigail.jirgi@futminna.edu.ng,
jacobtsado2007@yahoo.com, r.usman@futminna.edu.ng,
ayodejicoker@futminna.edu.ng, faith.ibrahim@futminna.edu.ng,
halima.sallawu@futminna.edu.ng, hsshabausman@futminna.edu.ng,
ezeziel.yisa@futminna.edu.ng, safil4real@gmail.com,
job.nmadu@gmail.com and km.baba@futminna.edu.ng

The education of the citizenry plays an important role in the economic development and advancement of any country like Nigeria. Therefore, the provision of quality education should be one of the cardinal objectives of the country as it paves the path towards poverty reduction through improved productivity. However, in Nigeria, there has been a decline in investment on education which has resulted in the deterioration of educational fixed assets, inadequate funding and declining standards. Hence, the research investigated the impact of the budgetary allocations to education (in the form of per cent GDP) as captured in the Nigerian social accounting matrix (SAM) of 2004, 2006 and 2012. In particular, the research studied the pattern of investment on education and how it has impacted import and export in the sector. The study also investigated the impact of investment in the sector on agricultural productivity of the Nigerian economy. The study used the SAM accounts of Nigeria and analysed them using General Computable Equilibrium (GCE) in GAMS codes adapted from IFPRI model and other sources to optimise, simulate and forecast investment on education from 2004 – 2050. The simulations were based on shocks to investments (15% reduction), export (1 %decrease) and import (20% increase). The results showed that the contribution of the sector to GDP remained static while agriculture's contribution remained static until a major reduction of almost 98% occurred in 2022. The study therefore concluded that reduction in educational investment has led to decline in human capital development exacerbating brain drain of human resources and incessant industrial actions by unions in the sector. There is marked reduction in demand for Nigerian education by other countries of the world which contributes to low inflow of foreign earnings. Hence the study recommends adequate investment in education so as to promote agricultural productivity and economic growth.

**PP150: Lifting lid on the black box of the impact of agricultural program's
interventions on farmer's production growth in Tanzania
(Abstract Id: A4-6-027)**

^aMosses Lufuke, ^aMary Kulwijila and ^bAgatha Ngowi
^aEconomics and Statistics, The University of Dodoma, Dodoma, Tanzania
^bPublic Health, The University of Dodoma, Dodoma, Tanzania
mlufuke@udom.ac.tz, kulwijila.mary@udom.ac.tz, agywin2009@gmail.com

This paper aims to find out whether statistical evidences vindicate the growth of farm income due to intervention strategies that have taken place in different regions of Tanzania. The data set used in this study was compiled from forty five farmer's groups of 1395 banana growers located in six different villages of Kagera region in Tanzania. Attention was drawn from four strategic areas that the program

intervention intended to reinforce, namely formation and formalization of groups through registration; provision of training on action plan development; linking the corresponding groups with financial institutions; as well as linkage with associations that are responsible in conveying marketing information. Statistics on production performance a year before (2015) and the second harvesting season (2017) after intervention were collected. Since the independent variable-treatments has only two levels, paired sample t-test is used to determine whether the mean production before treatments is statistically different from the mean production after treatments. Levene statistic was used to test the homogeneity of variances before interpreting actual statistical results. The findings of the study indicate that the differences in production performances before and after all strategic treatments that were offered to farmers are statistically insignificant. To address the magnitude of “dead-weight” interventions, it is suggested that the program strategies be configured specifically to align with set-up of the particular agricultural sub-sector.

PP151: Livestock sector and its contribution to the household economy in Tanzania
(Abstract Id: A4-6-006)

Gabriel Kulomba Simbila and Gabriel Kulomba Simbila
 Economic Statistics, National Bureau of Statistics, Dodoma, Tanzania
 National Bureau of Statistics
 sku.lomba@hotmail.com, gabriel.simbila@nbs.go.tz

Livestock sector and its contribution to the household economy in Tanzania. The research proposal focuses on the application of the econometric panel model on the microdata of the livestock sector, as a way of measuring value addition in the household economy, and understand its impacts on the sector. A large proportion of the rural population is partly or fully dependent on livestock for their livelihoods and most farming of livestock takes place on small-scale farms, which still holds little value added. However, the livestock sector has a great voltage to reduce poverty at the household level and contribute to the household economy. Its byproducts such as hides and skins are used as raw materials to the Leather industry. Despite the fact that the country is blessed for having many cattle, The evidence of the previous study has shown that livestock sector production has a lot of significant value added in the economy, but a great part of this potential resource still remains untapped. This is due to the fact that much of commercial livestock trading has not taken hold and livestock becomes not economically significant, its requests for further research. In this inquiry, three datasets from the National Panel Survey collected by the National Bureau of Statistics will be used and since the data is at the national level, it is scientific done and comprehensive. The Research findings will useful to policymakers for policy formulation in the livestock sector so as to reduce poverty at the household level. Keywords: Livestock industry and Poverty Justification Livestock sector supplements the income from crop production and other sources and absorbs income shocks due to crop failure. It generates a continuous stream of income and employment and reduces seasonality in livelihood patterns particularly of the rural poor Ali et al ., (2007). The household that owns livestock for the express purpose of producing for the market, in other cases, sales may be occasional to meet an urgent need for cash, such as paying school fees or medical costs. Livestock waste is often an important input for maintaining soil fertility, and so contributes to greater crop production for food and income Powell et al., (1998). In many mixed crop-livestock systems, larger animals function as farm equipment. Session Organizer details Mr Gabriel Kulomba Simbila Email: sku.lomba@hotmail.com Phone: +255 754 398065 Organisation Details National Bureau of Statistics, P.o. Box 2683, Dar es Salaam, Tanzania. 255 www.nbs.go.tz

PP152: Price cointegration analyses of edible oil market in India
(Abstract Id: A4-6-058)

India is a leading producer of edible oil in India and the world's largest importer. The demand and supply gap in the edible oils has a huge gap and imports accounting for 60 percent of the total requirement. The price fluctuation and volatility of edible oilseed are more than other agricultural commodities. Present studies attempt to analyze price behavior and the integration among different markets of major oilseeds in domestic markets of India. The Johanson cointegration test validates the existence of integration in oilseed domestic market in India. Vector autoregression (VAR) models were applied to capture price transmission effects between these markets. These are combined with a multivariate GARCH model to account for potential volatility transmission. The result reveals that price volatility was observed in Hyderabad, Chennai and Mumbai market.

PP153: Statistical analysis of farmer's club programme for enhancing farm income in Manipur
(Abstract Id: A4-6-036)

^aKh. Rishikanta Singh, ^bAnsari M.A, ^cT. Basanta Singh, ^dPunitha P, ^eI. Meghachandra Singh and
^dN. Prakash

^aAgricultural Economics, ICAR Research Complex for NEH Region, Imphal, India

^bAgronomy, ICAR Research Complex for NEH Region, Imphal, India

^cSoil Science, ICAR Research Complex for NEH Region, Imphal, India

^dAgricultural Extension, IARI, New Delhi, Pusa, New Delhi, India

^eSeed Technology, ICAR Research Complex for NEH Region, Imphal, India
rishikanta.ndri@gmail.com, merajiari@gmail.com, basantasinh.t@gmail.com,
puniasashok@gmail.com, meghais@rediffmail.com, nprakashicar@gmail.com

Farmer Club is one of the approach for technology dissemination and demonstration at village level. It works as a medium for transformation of agriculture at the grassroot level. It is an effective tool for doubling farmer's income and for achieving sustainable development goal especially No Poverty and Zero Hunger. The present study was conducted in Imphal West district of Manipur to examine the impact of Farmer's club programme on technology adoption and income generation. Among the various Farmer's club promoted by ICAR and KVK in Manipur, three Farmer club viz. Sangaitheh Farmer club, Khumbong Farmer club and Khabi Bamdiar Farmer club were randomly selected. Various trainings and awareness programme were conducted and new technologies were demonstrated at farmer's fields which include direct paddy seeder, pheromone trap, improved seed, package of practices, etc. For the present study a total of 150 households consisting of 75 members and 75 non-members were randomly selected from the selected villages. Primary data were collected through field visit and farmer's interview. Paddy was the major crop cultivated in the kharif season and most of the field remains fallow after paddy cultivation. It was found that 35 percent member cultivated improved rice varieties which include RCM 9, RCM 10, RCM 12 and RCM 13 while it was only 7 per cent for non-members. Average yield of rice per hectare was 4.7 tonnes for members while it was only 4.3 tonnes for non-members. Members incurred an average expenditure of Rs 46650 per hectare for rice cultivation while for non-members it was Rs 48492. Human labour and machine labour accounted for more than 75 percent of the total expenditure on rice cultivation in both the group. Members obtain a higher net return ie Rs. 39200 while for non-members it was only Rs. 29757. The B:C ratio for member and non-members was 1.84 and 1.61 respectively. Estimates of parameters of Cobb- Douglas production function for paddy cultivation of member household revealed that seed and human labour were the significant variables with R² value of 75 per cent. In case of non-member household, seed and fertilizer were the significant variable with R² value of 79 per cent. Binary logistic regression model used to analyze the factors affecting the decision for

participation in Farmer Club programme reveal that Cox and Snell R-square was 0.34 and Nagelkerke R-square was 0.46. It was found that cultivation of improved rice varieties and size of land holding are significant variables. Out of the total 75 members, 27 have adopted cultivation in rabi and summer season with an average earning of Rs. 26583 per household. In case of non-member, only 16 farmers cultivate field in rabi and summer season with an average earning of only Rs. 19170 per household. Overall, the statistical analysis of primary data revealed that Farmers Club has played a significant role in bringing agrarian reform at the grassroots level. It has resulted in increase in cropping intensity and adoption of improved rice varieties leading to an increase in average farm income.

PP154: Statistical study on growth and economics of gamhar based silvipastoral system
(Abstract Id: A4-6-068)

^aJwel Bhuiya and ^bSubrat Kumar Mahapatra

^aDepartment of Silviculture and Agroforestry, Odisha University of Agriculture and Technology,
Bhubaneswar, India

^bDepartment of Agril. Statistics, Odisha University of Agriculture and Technology,
Bhubaneswar, India

Jwelbhuiya007@gmail.com, smsubrat362@gmail.com

An experiment was conducted to” statistical study on growth and economics of gamhar based silvipastoral system” to evaluate the growth of gamhar with intercrops of forages under silvipastoral system of agroforestry in randomized block design(RBD) consisting seven treatments i.e. gamhar intercropping with Stylo, Thin Napier and Guinea grass, as well as sole gamhar, Stylo, Thin Napier and Guinea grass. The plant height and crude protein percent of all the forage in the intercrops was showed more as compared to sole gamhar plantations, which is more significant in T4 treatment (gamhar + Stylo) compared to other treatments. The total yield of forage intercrops of treatment T4 was also significantly higher than other. The net return of Gmelina arborea with intercrops of forage crop was found maximum of Rs.1,32,505/ha in treatment T3 in compare to sole stylo in T6 i.e. Rs. 64,117. The B.C. ratio was also maximum in T4 having 4.60. The result indicates that Gmelina arborea with intercrop of stylo grass is compatible to providing high economic returns.

PP155: Transfiguration of bank financing to investment and productivity in agriculture: The Indian case
(Abstract Id: A4-6-026)

Ravi Shankar and Vivek Kumar

Department of Statistics and Information Management, Reserve Bank of India, Mumbai, India
ravishankar@rbi.org.in, vivekkumar@rbi.org.in

Investment and working capital requirements in agriculture are met by both formal and informal channels. Under formal financing route, bank credit is the largest component. In India, the Reserve Bank's Basic Statistical Returns (BSR) system provides detailed information on bank credit, and has evolved as a major input in policy-making and monitoring its effectiveness. This study analyses the long-term behaviour of banking credit to agriculture sector during 1972-2018. With the modernisation of the economy, the share of agriculture in national output has steadily declined during this period but less reliance on informal financing and larger role of bank credit presents an interesting picture. Setting up of dedicated system of regional rural banks as well as directed public policies gave fillip up to a point, whereas there was also a gradual surge in competing demand for industrial and personal

bank loans. The study period witnessed several phases of differing movements in bank credit, both in terms of amount as well as number of loan accounts. We observe three structural break-points in levels (intercepts) indicating that bank credit to agriculture witnessed high annual growth of about 26 per cent in initial phase of banking expansion during 1973-1984 which moderated to about 12 per cent in the next sixteen years. In the subsequent period, the behaviour of agricultural credit growth was different before and after the global financial crisis, which induced definite moderation in it. In India's federal structure, nearly half of the agricultural credit is accounted by five major states (viz., Tamil Nadu, Uttar Pradesh, Andhra Pradesh, Karnataka and Maharashtra) and these states also contribute to the national granary. Interestingly, the dominant position of these states has remained intact during last fifty years though certain other states (Rajasthan, Punjab and Madhya Pradesh) are catching up. Over two-thirds of the credit to farmers remains in the form of crop loans and the share of medium, small and marginal farmers remains very low. As a result, a minuscule portion of credit is directed for investment and capacity building to augment future output on a sustained basis. An empirical examination of the relationship between agricultural credit by banks and output of agriculture sector indicates that credit intensity has increased substantially during the last two decades in sync with the rapid expansion in bank credit to agriculture. Trends in incremental credit and growth in agriculture highlights the role of incremental credit in growing output of agriculture sector. Empirical investigation reveals the varying nature of credit-output relationship: compared to the earlier disconnect between bank financing and output in the agricultural sector, the effects are more pronounced in recent times. Though the growth in agricultural GDP remains highly volatile in India, as rainfall conditions are important factor, incremental bank credit has significant and positive influence on growth in the agricultural sector. Though the low levels of debt-to-assets ratio augurs well for expanding bank credit, we also study the role of households' indebtedness and limits from the declining size of land holdings on credit absorptive capacity of sector.

PP156: Agricultural Census data valorization - Importance of adding more value to census data using known analytical tools for policies use
(Abstract Id: A4-6-063)

^aEloi Ouedraogo, ^aAnkouvi Nayo and ^bUlrich Nyamsi

^aStatistic division, FAO, Rome, Italy

^bEmergency and Resilience Division, FAO, Rome, Italy

The agricultural census is a high financial resource consuming (heavy burden) activity, mainly for developing countries. Owing to its usefulness in providing structural data for sampling frame and planning purpose, advocacy is always made to support and encourage countries to conduct agricultural censuses. If these objectives are relevant for all countries and mainly for developed countries with well-settled agricultural statistics systems providing a flow of data satisfying majority of needs, it is not the case for most developing countries. For the latter, agricultural censuses are worth a huge part of the country budget and the census is always competing with other urgent needs and development projects. In this context, it is necessary to raise the following concerns: · How best do countries make use of the agricultural censuses collected data? · What is the current status for dissemination of census data and findings? · How best can the use of census data be extended to provide more added value of agricultural censuses? These concerns seem to be topical in the need for improving advocacy for census funding. It is necessary to demonstrate more the usefulness of the census and its cost-effectiveness by showing the wide range of the data utilization beyond the traditional justification including statistical tools for frames updating and statistics generation for policies formulation. Beside of responding to those questions, this paper presents how the use of techniques such as microsimulation and other projection techniques using agricultural census data can shed more light on agricultural policies and therefore improve data value and use.

PP157: Agricultural insurance administration and challenges in developing countries: Evidence from Georgia

(Abstract Id: A4-6-020)

^aDemna Dzirkvadze and ^bAleksandre Maisashvili

^aForeign Agricultural Service, U.S. Department of Agriculture, Tbilisi,
Georgia,

^bAgricultural and Food Policy Center, Texas A&M University, College
Station, Texas, USA

demnaus@gmail.com and amaisashvili@gmail.com

Natural disasters hit hard and frequently they cause substantial losses to farmers. In developed countries, agricultural insurance is considered to be one of the most critical and widely used risk management tools for producers of major field crops, perennial crops and livestock. For instance, in the U.S., not only do producers rely heavily on agricultural insurance, but government-provided reinsurance and premium subsidies represent large expenditures for the taxpayers. Considering that big portion of premiums are subsidized by taxpayers, the actuarial fairness of crop insurance premiums is therefore a question of great importance. Developed countries have luxury of having long historical time series data and loss experience, making the ratemaking process more or less actuarially fair. When it comes administering agricultural insurance products in developing countries, many problems arise. If done correctly, agricultural insurance products may reduce farmer risk, boost average productivity, and increase access to credit. However, developing countries frequently have very limited historical price and yield data, let alone history of loss experience. In many cases, these limited data have observational errors, structural breaks, and missing observations, to name a few. All these obstacles make ratemaking process a very difficult task. In this paper we apply several existing methodologies of crop insurance ratemaking process when there are very limited or no historical data available that are specifically applicable to developing countries. We will consider both index-based and indemnity-based insurance products and discuss the benefits and drawbacks of each two. To accomplish these tasks, we will employ both parametric and non-parametric methods to simulate prices and yields for loss and ratemaking calculation and, in addition, we will incorporate uncertain random variables such as drought, hail, rust, and frost. We will discuss the challenges and common reasons of failure of insurance products in developing countries. In many cases these programs have strong social objectives backed by the government, making the products less efficient and sustainable. In the last section, we will compare the results to the pilot crop insurance programs currently administered in Georgia.

PP158: Assessing the impact of "jajar legowo" planting system on wetland paddy productivity and income of farmers in Indonesia
(Abstract Id: A4-6-015)

Octavia Rizky Prasetyo and Kadir

Subdirector of Food Crops Statistics, BPS-Statistics Indonesia, DKI
Jakarta, Indonesia

octavia.rizky@bps.go.id and kadirsst@bps.go.id

Paddy is an extremely strategic commodity in Indonesia. The demand for rice continues to increase along with the population growth since most Indonesians rely on rice as their staple food. As the consequence, paddy production plays a vital role in maintaining national food security. In recent years, Indonesian government is implementing several programs focusing on both expanding paddy field and increasing productivity. However, the former measure is costly and not easy to be implemented. In fact, the paddy area has been decreasing for many years because of massive conversion of agricultural land, especially paddy field, into non-agricultural uses such as residential

and industrial land. Therefore, the last strategy becomes the most promising one. In order to boost the productivity of wetland paddy, the Ministry of Agriculture has introduced a new cultivation technique so-called "Jajar Legowo" planting system as a flagship program. Technically, it tries to optimize the population of paddy plants per hectare by adjusting the space or the distance between the plants. The implementation of the technique is also expected to enhance the income of the farmers as a result of better efficiency. This study is aimed to assess whether the new cultivation planting technique has a significant impact in increasing the productivity of wetland paddy and income of the paddy growers in Indonesia. In doing so, we applied a regression model on the results of the 2017 National Food Crops Cost Structure Survey conducted by BPS-Statistics Indonesia in all 34 provinces. The main contribution of this study is to provide an evaluation on the performance of the "Jajar Legowo" planting system in increasing paddy productivity and income of the farmers. Therefore, our study can be used by the government as a reference for future improvement of the implementation of the "Jajar Legowo" cultivation system. Our findings show that the new cultivation system has a significant impact in increasing the productivity of wetland paddy. Without controlling for other variables affecting productivity, the estimation result pointed out that on average the new cultivation system can increase productivity by about 9 percent. However, after controlling for other variables (the farmers and other cultivations characteristics), the magnitude decreases to around 6 percent. Moreover, our estimation results also show that the income of the farmers rises by around 13 percent due to the implementation of the new planting system indicating a better efficiency than that of the conventional one.

**PP159: Strengthening fisheries management system in Malawi with information communication technology (ICT) data
(Abstract Id: A4-6-007)**

Mexford Mulumpwa
Department of Fisheries, Monkey Bay Fisheries Research Station, Mangochi,
Malawi
mulumpwa.mexford@gmail.com

The fisheries in Malawi are classified into traditional and commercial fisheries. The commercial fishery comprises of stern and pair trawlers. Illegal gears, dynamism and open access nature of fisheries resources pose a challenge to management of traditional fisheries. Management of the large-scale fisheries has been encountering several challenges engine size and trawling speed (over 40hp), fish poaching, use of under meshed gears, under reporting of catch, illegal fishers and extended fishing time. The ICT as vessel monitoring system (VMS) data, media (i.e. radios), cell phones and satellite images are offering hope of dealing with most of fisheries management challenges in Malawi. The VMS is enabling monitoring of fishing-restricted-areas, trawling speeds, fishing duration and fishing effort. Malawi is piloting the first inland fisheries management system with VMS in Africa. The media is encouraging adoption of fisheries management successes among local fishing communities. Use of high definition satellite images can assist in conducting annual fisheries frame survey at a click of a button. ICT data in Malawi is offering hope in fisheries management hence ensuring sustainable fisheries management. This is eventually ensuring continued provision of fish as a cheapest animal protein on the market in the future thereby enhancing national food security.

**PP160: Construction of a multi-layer weighted index to assess food and nutrition security (FNS) within a geographical boundary
(Abstract Id: A5-7-014)**

Sudipta Paul, Premlata Singh, Satya Priya and Sangeetha V
Agricultural Extension, ICAR-IARI, New Delhi, India
sudiptaiari@gmail.com, premlataashok@gmail.com,

Food and nutrition security (FNS) is the global agenda of development discourse, especially in underdeveloped and developing countries. Although some evaluation approaches, like dietary diversity (DD), food consumption score (FCS), per capita calorie consumption (PCC) and coping strategy index (CPI) are available to guide us in developing an elementary idea about the status of FNS, the procedures are limited mainly to individual and household level estimations. FAO (2000) conceptualized FNS altogether in a different perspective, in which it was stated that FNS is achieved, if adequate food (refers to quantity, quality, safety, and socio-cultural acceptability) is available and accessible for and satisfactorily utilized by all individuals at all times to live a healthy and happy life. The underlying assumptions of this definition are clear- (1) food may be available in sufficient quantity within a geographical boundary, but may not be accessible to all inhabiting within the same geographical boundary, (2) even if it is accessible, may not be utilized satisfactorily by all within the geographical boundary. However, there is hardly a measurement tool available to quantify the framework holistically for estimation of FNS of a geographical area- a village, block, district etc. Unavailability of such an important tool blurs the vision to look at the FNS status as a whole of a district and state, and compare it with the other districts and states in an easy yet efficient manner. The present multi-layer weighted index, as constructed and proposed to be presented in the upcoming conference is an effort in this specific direction. It uses a total of 46 indicators, carefully screened and/or worked out under the three major pillars of FNS as specified by the FAO- availability, accessibility and utilization. The index is multilayered in the sense that it comprises base layer indicators (46) to constitute two intermediary layers of indices (16, 3) in order to finally boil down to the Food and Nutrition Security Index (FNSI). The indicators cover dimensions of food and nutrition to the highest extent possible yet maintaining scientific parsimony of analysis and interpretation. A combination of both objective (Shannon's entropy) and subjective (food group weightage assigned by the FAO, experts' judgment) weighting schemes were adopted for assigning relative importance to the constituent indices (16) and indicators (46) of FNS. Cross sectional district level data, collected from authentic secondary sources, with respect to 13 districts of Bundelkhand region (both from Uttar Pradesh and Madhya Pradesh) of India were made use of in the entire process of estimation. Results of the study suggest that among the Bundelkhand districts, Datia (5.00), Lalitpur (3.95) and Chhatarpur (3.03) are the most secured whereas, Sagar (1.94), Banda (2.43) and Hamirpur (2.49) are the least secured in food and nutrition combined. Advancing such a multi-layer, weighted, composite index will have important implications on FNS programme planning at the district level in the sense that it will aid in identification of potential sources of food insecurity and poor nutrition, and will also help in establishing relationships with other district level parameters.

**PP161: Determinants of the food resilience of households in a shock situation:
Case of the far north of Cameroonl
(Abstract Id: A5-7-016)**

Akeza Fleury Lajuste and Anakeu Etienne
Mfoundi, ISSEA, Yaoundé, Cameroon
ayusitanikbea@gmail.com and djoumessicadeau@yahoo.fr

Food resilience is a new priority for non-governmental organizations and United Nation agencies seeking to assist the poorest populations. In Cameroon, the Far North region is the most vulnerable with a high prevalence of food insecurity (33,6% of households are food insecure according to the survey "Comprehensive Food Security and Vulnerability Analysis" CFSVA 2017). Despite all the efforts made, this is not enough to return the spiral of household vulnerability. For strengthening people's ability to recover from their fragility, emergency measures must go with development solutions. Then, this study aims to identify social, demographic, economic (agricultural and non-

agricultural), technological, physical (health, educational, protection) and even financial parameters that may increase or reduce the probability of a household being resilient or not to a shock or crisis. To achieve this goal, CFSVA 2017 data was used. The analysis methodology is based on descriptive statistics and econometric regression. The analyzes revealed that agriculture is a very important factor in explaining food resilience. In fact, compared to a non-farm household, an agricultural household that has grown less than 2 hectares of land has 0,38 times less chance of resilience. Similarly, a household that has exploited more than 2 hectares is 0,43 times less likely to cope with shocks. On the other hand, access to basic services (electricity, water and modern sources of fuel for cooking) as well as the possession of assets such as a living house have a positive influence on food resilience.

The results also showed that the more a household has many sick members, the more he's less resilient, as logically this would lead to additional expenses that can reduce the budget allocated to household food. Nevertheless, this study is only one side of the resilience analysis and a dynamic analysis would be more appropriate for this type of study.

**PP162: Determinants of the quality of food use by urban households areas in areas at risk of food insecurity in Cameroun (East, Adamawa, North and Far North)
(Abstract Id: A5-7-009)**

^aIgnace Kamga Tchwaket, ^bAnakeu Etienne and ^cSonna Gandhi
Emmanuel

^aDIRAC, ISSEA, Yaoundé, Cameroon

^bDESA, MINADER, Yaoundé, Cameroon

^cDPIP, MINEPAT, Yaoundé, Cameroon

^akamignace@yahoo.com, ^bdjoumesticadeau@yahoo.fr and

^csfge68@gmail.com

The aim of this document is to identify the explanatory factors for the quality of food use by households living in urban areas in the four study regions (Adamawa, East, Far North, and North) in Cameroon. Nowadays, the quality of food products have become a priority for consumers and remains one of their first expenditure Items. Literature showed that, the proper diet of household depended on the factors related to household profile, its socio-economic factors, housing status or nutritional preferences. A theoretical framework was constructed, and data from the 2017 Food Security Monitoring System (FSMS) was used to perform descriptive analyzes using the Chi-Square, Multiple Correspondence Analysis (MCA) test, and explanatory by a binomial logistic regression. The results obtained at the descriptive level show that households living in urban areas are headed mainly by a male (78.9%). In addition, the region, the literacy level of the household head, the evolution of household income, the presence of at least one case of chronic illnesses in the household and the food consumption score (SCA) have an influence on the quality of food consumed by households in urban areas. The ACM indicates that households making good use of food stuffs are found in the East region; their priority is something other than food. Moreover, these households have never used a strategy of stress, crisis or emergency; have an acceptable food consumption score and their family head is a monogamous married man with at least high school diploma. At the explanatory level, determinants of the quality of food use by urban households are: the region where the household is located, the use of a consumption strategy, the average amount of water consumed per person in the household, the presence of at least one case of chronic illnesses in the household and the food consumption score. The recommendations made are in line with the regular monitoring of food stocks in these regions in order to make it easier for households to have at least an SCA (SCA > 21) .and awareness of the population on the prevention of chronic diseases.

PP163: Does the convergence approach of food security indicators lead to different

results?
(Abstract Id: A5-7-024)

Amal Mansouri
High commission for Planning, High commission for Planning, Rabat,
Morocco
amal.mnsr@gmail.com

Measuring the Food security has been a key issue in international discussions. A variety of composite indicators has been implemented in order to evaluate and compare needs of food security status in countries. Most of these indicators capture the dimensions of availability and the accessibility of food security as well as the effects in terms of anthropometric indicators. Our analysis focuses on analysis and evaluation of the convergence between the under-nourishment indicator and the anthropometric indicators on a sample of four countries. To this extent, we have used data provided by the Food and Agricultural Organization, over the period 2000-2016. The convergence approach is verified, namely with the use of the cointegration test.

**PP164: Food balance sheets: A key instrument for two SDG Indicators 2.1.1
(prevalence of undernourishment) and 12.3.1.a (global food loss index)**
(Abstract Id: A11-12-005)

Jitendra Singh Tomar and Sangita Dubey
Agricultural Statistics, FAO RAP, Bangkok, Thailand,
jeet.iasri@gmail.com and sangita.dubey@fao.org

Asia Pacific region contains the world's largest population and is its most rapidly developing continent. As this growth escalates, new challenges of achieving SDGs emerge. At present this region is home to more than half a billion (59%) of the world's undernourished people and prone to food losses. It is a warning that there is considerable work to be done to make sure we "leave no one behind" on the path towards a world with zero hunger and sustainable consumption and production. Food Security is a multi-dimensional phenomenon, and to address this and monitor progress necessities strong policies and actions grounded with timely and reliable data. The most widely used data sets in the field of food availability or consumption are obtained through food balance sheets (FBS). A FBS is an aggregated and analytical data set that presents a comprehensive picture of the pattern of a country's food supply and utilization during a specified reference period. The ultimate output of FBS is dietary energy supply (DES) estimate. FBS data has numerous applications and within the SDG framework, FBS contribute significantly in the calculation of the Prevalence of Undernourishment (PoU) and establishing baseline for the Food Loss index. PoU is an estimate of the proportion of the population whose habitual food consumption is insufficient to provide the dietary energy levels that are required to maintain a normal active and healthy life. One of the basic parameters required to estimate PoU is average Dietary Energy Consumption (DEC) and generally calculated from country's household consumption and expenditure survey (HCES) data. However, HCES are primarily designed to inform economic policies, not for food security analysis and surveys are resource intensive so more-or-less not undertaken in regular basis in many countries. FAO has traditionally relied on alternative source FBS, to compute the DEC from adjusted DES, as FBS are available regularly for more than 150 countries. The third target under SDG 12 calls for reducing food losses along production and supply chains, including post-harvest losses by 2030. The issue of food loss of great importance in the efforts to combat hunger and raise incomes. However, national estimates on food loss along entire food chain have not been carried out so far due to complexities of supply chains and challenges in measuring it across all dimensions. Being a custodian agency of this indicator, FAO has developed the methodology and recommended for layering of information to keep loss measurements cost effective. A common base period (2015) is needed to compile comparable

FLI. FBS data on losses may be used to establish baseline estimates or to validate the collected data. FAO, in partnership with the Global Strategy to Improve Agricultural and Rural Statistics (GS) has improved the FBS compilation methodology, developed Shiny tool and advanced national capacities for its compilation. In nutshell, we can say that FBS, HCES and PHL statistics should be used in a complementary manner and to cross validate each other and will go beyond the timeframe of the SDGs.

PP165: Impact of Climate-Smart Innovations Adoption on Productivity and Food Security of Farming Household in Benin: A Case Study of Drought Tolerant Maize (DTM) Varieties
(Abstract Id: A5-7-002)

^aTchégoun Michel Atchikpa, ^bShérif Sidy Kane, ^cJustice A. Tambo, ^dTahirou Abdoulaye, ^eJacob Afouda Yabi and ^fAhamadou Aly Mbaye

^aDoctorate Program (GRP) on Climate Change and Economics (CCEcon)) at University of Cheikh Anta Diop of Dakar (Senegal) and Faculty of Agronomy, Benin, West African Science Service Centre on Climate Change and Adapted Land Use, Senegal

^bFaculté des Sciences Economiques et de Gestion, University of Cheikh Anta Diop, de Dakar, Senegal

^cCenter for Agriculture and Biosciences International, Delémont, Switzerland

^dSocioeconomic Unit, International Institute of Tropical Agriculture, Ibadan, Nigeria

^eFaculty of Agronomy, Benin, University of Parakou, Benin

^fDoctorate Program (GRP) on Climate Change and Economics (CCEcon)) at University of Cheikh Anta Diop of Dakar (Senegal) and Faculté des Sciences Economiques et de Gestion, University of Cheikh Anta Diop, de Dakar, Senegal

atchikpa.t@edu.wascal.org, cherifsidy@yahoo.fr, j.tambo@cabi.org,
T.Abdoulaye@cgiar.org, Ja_yabi@yahoo.com, mbayealy93@yahoo.fr

Climate change is now known as a significant threat to agricultural production and food security in West Africa, especially in Benin, and climate-smart agriculture is essential to cope with the potential impacts by disseminating some climate-smart innovations with a goal to increase productivity, yield, income, food security, nutritional status, and poverty. This paper examines with a case study on Drought tolerant maize (DTM) varieties, the impact of climate-smart innovations adoption on productivity and food security, using country-wide cross-sectional data of about 518 maize farming households from 48 villages in Benin. We used respectively yield, household food expenditure per capita, household food consumption scales (HFCS), household diet Diversity Score (HDDS) and household food insecurity experienced score (HFIES) as outcome indicators of productivity and food security of maize farming households in Benin. We used a mixed methods approach based on qualitative techniques (group discussions and in-depth interviews with various key stakeholders) for the data collection on the first hand. The quantitative techniques (Endogenous Switching Regression (ESR)) permits to identify the causal effects of adopting drought-tolerant maize varieties on the productivity and food security of maize farming in households in Benin using two instrumental variables. Significant differences in socio-economic, demographic and institutional characteristics between adopters and non-adopters of Drought tolerant maize varieties were established and found. To control, such differences and allow a causal interpretation of the real effect of Drought tolerant maize varieties adoption, we have estimated the Average Treatment Effect (ATE). In the end, our analyses have indicated that adoption of Drought tolerant maize varieties adoption significantly increased respectively household food expenditure per capita by about 1.44%, the household food

consumption scales (HFCS) by about 31.83%, the household diet Diversity Score (HDDS) by about 2.34% and decreased the household food insecurity experienced score (HFIES). These results showed that adoption supports severely food insecure households to reach moderate and acceptable food security status by empowering them to acquire cereals and tubers, pulses, vegetables, and fruits daily. There was no significant impact of Drought tolerant maize varieties adoption on yield. Our findings point out that Drought tolerant maize varieties can play an essential role in farm performances in Benin and indirectly in food security.

**PP166: AHP approach for suitability analysis of cereal crops in Bundelkhand
(Abstract Id: A6-8-025)**

Rajni Jain, Prem Chand, Sulakshana Rao, Suresh Pal and Priyanka
Aggarwal
ICAR-NIAP, ICAR-National Institute of Agricultural Economics and
Policy Research, New Delhi, India
rajni.jain@icar.gov.in, prem.chand@icar.gov.in,
raosulakshana1990@gmail.com, spl.econ@gmail.com,
priyankaagarwal131@gmail.com

Bundelkhand is a mountain range in central India. It is divided between the states of Uttar Pradesh and Madhya Pradesh, with the larger portion lying in the latter state. Water is the biggest problem in almost every district of Bundelkhand whether it is Banda or Lalitpur. Most of the people here depends on agriculture and cultivates wheat, paddy, maize, jowar, gram, arhar, masur, sesame, soyebean and groundnut. Productivity of crops is low in this region. The region also faces frequent draughts. For sustainable agriculture in the region, there is a need for identifying suitability level of crops. Crop suitability analysis is a pre-requisite for sustainable agricultural production in a region. Evaluation of the region should be done based on not only bio-physical parameters like soil, climate, topography but also based on socio-economics parameters like market infrastructure, crop profitability etc. It also needs some approach for multi-criteria decision making. Analytical Hierarchy Processing Approach has capability of blending of expert knowledge and judgement into the analytical process at various levels of decision making. The present study identifies suitability of cereal crops in Bundelkhand. Crop suitability is determined into categories S1, S2, S3, and N which are recommended by Food and Agricultural Organization in its land evaluation framework. Each attributes were standardised and matched with the respective thresholds (attribute value based criterion for each suitability class) determined separately for each crop based on secondary sources and expert knowledge. The step wise details for crop suitability analysis are as follows: (i) Selection of region and crops (ii) Identification of criteria attributes and their categories & hierarchies (iii) Data collection and standardization of each parameter and attribute (iv) Expert opinion for relative importance of different criterions for pairwise comparison (v) Determination of suitability class in the identified region by matching available attribute values with S1, S2, S3 or N requirements (vi) Identification of crop requirements for each attribute and criteria for S1, S2, S3 and N categories of suitability (vii) Determination of criterion weights using AHP (Analytical Hierarchical Process) (viii) S1, S2, S3 or N classification for attribute or intermediate level hierarchies based on associated attributes' weights (ix) Suitability determination based on top level hierarchies and associated weights Suitability score of major cereals namely sorghum, maize, paddy and wheat was first determined for biophysical, irrigation, market access, availability of roads and socio-economic criteria separately. Later, overall suitability was determined using multi-criterion decision making. The results indicate that none of the cereal crop that is presently cultivated in Bundelkhand is highly suitable for the region. Most of the crops are moderately suitable (S2). Maize and wheat in Hamirpur and maize in Jaulan are marginally suitable (S3). This concludes that based on bio-physical conditions and infrastructural availability, cereal crops are not highly suitable in the region. But nearly two million hectare area is covered under these crops. Therefore, to enhance farm income, there is a need to improve technology and crop management methods for these crops in Bundelkhand region.

**PP167: Recent experiences in measuring sustainable agriculture production in Kenya
(Abstract Id: A6-8-005)**

^aAmy Heyman and ^bJohn Mburu

^aSP2, Food and Agriculture Organization, Rome, Italy

^bAgriculture Statistics, Kenya National Bureau of Statistics, Nairobi,
Kenya

Amy.Heyman@fao.org and jmburu@knbs.or.ke

Kenya covers an area of 591,971 square kilometers and in 2018, it had a projected human population of 46.6 million. To feed this population, the country relies on local production as well as imports. Due to the arid nature of 80 per cent of the country coupled with the negative effects of climate change, the country has increasingly been depending on food imports to meet domestic supply. This is despite the fact that agriculture is the dominant sector of the country's economy and contributes about a quarter of the country's Gross Domestic Product. The country therefore acutely recognizes the need for sustainable food systems in order to realize food and nutrition security of the population. The goal of achieving food and nutrition security at the international level is well documented in Goal 2 of the Sustainable Development Goals (SDGs). For sustainable Agriculture Production and consumption at the local level, the government has identified food and nutrition security as one of the main pillars of its Big Four Agenda. This agenda is mainstreamed in the country's long term plan (Vision 2030) as well as the third Medium Term Plan (MTP III). The Kenya National Bureau of Statistics (KNBS) in conjunction with the United Nations Food and Agriculture Organization (FAO) and the Global Strategy for Agriculture and Rural Statistics (GSARS) has been making deliberate efforts at measuring Sustainable Agriculture Production (SAP). The SDG indicator 2.4.1 "Proportion of Agricultural Area under productive and sustainable Agriculture" is used to measure and monitor SAP. In 2018, an Agriculture Survey was conducted through a purposively selected sample of farming households in Kirinyaga county in Kenya. The objective of this survey was to conduct cognitive and extended tests using a designed questionnaire for SDG 2.4.1. In 2017, the KNBS with support from FAO/GSARS also conducted a survey in three counties namely Murang'a, Kiambu and Machakos. The objective of the survey was to measure Decent Work and Youth Employment in Agriculture (DW). The data collection during the survey used Computer Assisted Personal Interviewing (CAPI). This paper outlines the lessons learnt during the administration of the two Agriculture surveys in 2017 and 2018. Overall, one of the main success story, courtesy of the 2018 Agriculture Survey is that the SDG indicator 2.4.1 has since been moved from Tier III to Tier II. For Tier III, there is no universally agreed methodology. For Tier II indicators, the requisite methodology is known and well documented. Immediate benefits of the two surveys include refinement and validation of SDG indicator 2.4.1 methodology, production of DW indicators as well as capacity building on CAPI.

**PP168: Food loss index: layering of information is need of the hour
(Abstract Id: A6-8-020)**

^aJitendra Singh Tomar, ^bCharuwan Bangwaek, ^bRam Krishna Regmi and
^cBirendra Kayastha

^aStatistics, FAORAP, Bangkok, Thailand

^bAgriculture, MOALD, Kathmandu, Nepal

^cStatistics, CBS, Kathmandu, Nepal

jeet.iasri@gmail.com, c_haruwan@yahoo.com, rkregmi@yahoo.com,
birendra_kayastha@yahoo.com

One person out of every nine in the world (10.9%) is undernourished and In Asia-Pacific region

(11.4%) the situation is more serious, around one out of every eight (SoFI, 2018). At the same time roughly one third of the food produced in the world for human consumption every year get lost or wasted. In the region, approximately 42 percent of fruits and vegetables and up to 30 percent of grains produced accounts food loss between production and the market. This region contains the world's largest population and also home for significant number of small scale farmers, who produce enough food for all. However, more than half a billion of the world's undernourished people live in this region. This region is most rapidly developing continent and future will see further profound changes. As this growth escalates, new challenges of achieving SDGs in general and SDG 2 and 12 in particular will emerges. Increasing agricultural production is one aspect of fulfilling food demand and the efficient use of food materials produced and saving them as much as possible is another and better option without straining our natural resources and environment. The issue of food loss and waste is of great importance in the efforts to combat hunger, raise incomes and improve food and nutrition security. SDG 12 seeks to "Ensure Sustainable Consumption and Production Patterns." The third target (12.3) under this goal calls for halving per capita global food waste at the retail and consumer levels and reducing food losses along production and supply chains, including post-harvest losses by 2030. Being a custodian agency FAO has developed methodology for measuring, monitoring and estimating food losses under the scope of the SDG Indicator

12.3.1. SDGs are the opportunity as well as a challenge and success of the SDGs will depend on new and effective ways of collecting and analyzing data, monitoring targets and measuring progress by national governments. FAO globally and in the region has been actively involved in improving the technical capacity of the Government officers to measure losses. However, given the complexities of supply chains and the challenges in measuring losses across all dimensions of the problem, obtaining reliable information on losses at national level is challenging. There is no single solution as no one-fits-all and a strategy for prioritizing data collection efforts is need of the hour. The best approach is sample surveys for baseline loss data collection. However, this can be afforded by few countries as conducting surveys are very resource intensives. To make it cost effective, it is recommended to use the existing surveys and information systems to collect loss data. FAO through its technical cooperation projects with national governments in the region are exploring the existing surveys and information sources to identify the loss data availability, gaps and strategy to fill these gaps.

PP169: Quantification and benefits of reducing post-harvest losses: evidence for vegetables in Senegal
(Abstract Id: A6-8-029a)

^aAssane Beye and ^bAdam M. Komarek

^a Economics, Cheikh Anta Diop University of Dakar (UCAD), Dakar, Senegal

^b Environment and Production Technology Division, International Food Policy Research

Institute, Washington DC, USA

assane1.beye@ucad.edu.sn, a.komarek@cgiar.org

In a context characterized by a rapid increase in the global population and so demand for food, reducing post-harvest losses (PHL) could be a major contribution to meeting this global food demand through improved resource efficiency use. Indeed, reducing PHLs along food chains can be a way of promoting more sustainable and effective food and nutrition security than investments to increase production. This potential impact of PHL reduction has motivated its integration as part of the Sustainable Development Goals under SDG 12.3 by 2030. This study examined post-harvest losses (PHL) for vegetables and cereal in Senegal and the potential economic benefits associated with reducing PHL for vegetables. Household survey data were used to quantify the on-farm PHL for different crops and at different stages between harvest and sale or consumption. A multi- market model was used to simulate the effect of eliminating vegetable PHLs on the total value of vegetable supply and international trade of vegetable. The results show that the vegetable grower suffers more from PHL than cereal or pulse producers. Among the three the vegetable analyzed, losses are higher

for onion with 32.1% of production lost. Regarding tomato, surveys show a post-harvest loss rate of around 29.8% in Senegal while for pimento, the post-harvest loss is estimated at 29.8% of total production. For cereal crops and pulses, losses are respectively estimated at 3.6% and 4.2% of total production. The average loss rate on cereals mask the heterogeneity of losses among specific cereal crops among households including 3.1% for millet, 3.5% for maize, 4.1% for rice, 3.7% for sorghum, and 2.0% for fonio. In pulses, the estimated Post-harvest losses is distributed between groundnut (4.5%) and cowpea (2.6%). Results of the multimarket model suggest that on average 30% of vegetable production is lost on farm and unavailable for sales or consumption. Eliminating these losses could increase the total value of supply by US\$126 million per year and reduce imports by 127,000 tons per year. Our study provided an examination of the potential gains from reducing vegetable PHL, the costs, both private costs for farmers and public costs for government, to achieve this reduction would need careful consideration when planning investments in the agricultural sector.

PP170: Dynamic impacts of climate changes and agricultural sustainability on food-water poverty in a panel of selected MENA countries
(Abstract Id: A6-8-011)

^aJemmali, ^bMorarr and ^cBen Aissa

^aHigh Institute of Accountancy and Business Administration, University of Manouba, Manouba

^bEconomic Department, University El Najah, West Bank, Palestine

^cCollege of Economic Sciences and Management of Tunis, University of Tunis El Manar, Tunis, Tunisia

The linkages between food-water poverty and the climate changes, agricultural sustainability and environment conservation are already under-studied in the literature. These challenges commonly encountered by under-developing countries, while the majority of Middle East and North African (MENA) countries has no exemption to escape out from this food-water poverty nexus due to inappropriate socio-economic and environmental policies of sustainable development. This study examines the dynamic interconnections between climate changes, agricultural sustainability and environmental and food-water poverty in a panel of selected MENA countries over the period of 1990–2016 using a pooled OLS, fixed effects and random effects regressions techniques. Sargen-Hansen test shows that country-specific shocks affect the food depth and water poverty in term of access to sanitation models; therefore, the fixed effects model gives a better fit model than that of the pooled random effect model for these variables. The overall findings conclude that there is substantial required to increase agricultural sustainability in the MENA countries without deteriorating environment and water reserves. Policymakers should reconsider, in this regard, the dilemma of food-water poverty and formulate appropriate policies that aimed to feed poor people and offer them regular access to improved water and sanitation facilities.

PP171: Groundwater and energy nexus in irrigation development of India
(Abstract Id: A6-8-012)

Prabhat Kishore, Dharam Raj Singh, Prakash P and Denny Franco

Agricultural Economics, ICAR-NIAP, Delhi, India

kishore.prabhat89@gmail.com, drsingh@iari.res.in, prakashiari@yahoo.com, dennyiari@gmail.com

In India, irrigation was one of the key factors for green revolution in mid 1960s. Since then, government incentive to install water extraction unit at farmers field and subsequently electricity subsidies for its operation have rocketed number of tubewell in the country. Irrigated area to net sown area has increased from nearly 18 % in 1950 to 48 % in 2013 due to concerted effort of government at

various levels in its various five year plan. At present, in addition to 99 major and medium irrigation projects, 21.7 million minor irrigation structures support irrigated farmland. With this infrastructure, potential of 89.5 million ha area has been created of which about 80 % is being utilized. However, 97 per cent of minor irrigation infrastructure is owned by individual farmers or group of farmers and rest by government. For working of irrigation infrastructure, electricity acted as major source of energy and significantly increased from 56 % in 2006-07 to 71 % in 2013-14 at national level. For the same duration, share of diesel as energy source has decreased from 32 % to 25 %. Electricity consumption in agriculture has annual grown at 5.5 % and electricity consumption per hectare (net irrigated area) grown at 3.85 % in absolute term during 2000 to 2014. There has been spatial variation in growth rate of energy use depending on regional cropping pattern. Analysis indicates that electricity is dominant source of energy in all regions except eastern plain and Himalayan region. Groundwater which considered being more reliable and timely source of irrigation has increased from nearly 30 % in 1950 to 62 % in 2013-14 whereas canal irrigation has decreased from 70 % to 38 % for same period. But, groundwater table across state for TE2002 and TE2016 at 502 districts reveal that depletion of water table occurred in 321 districts (64 %). Further, in 132 districts (26.23 %) depletion of water table was more than 5 meters ranging up to 178 meter depletion in Jhunjhunu district of Rajasthan for same period. To extract groundwater, the total number of deep tubewell has grown significantly from 0.1 million in 1987-88 to 2.6 million in 2013-14 and 98.1 % of it, is electrified. 76 % of total pumping hours of deep tubewell is been done in 5 states namely Andhra Pradesh, Telangana, Haryana, Punjab and Rajasthan which fall under in peninsular hard rock and western plains. In these regions, electricity is available either free or at nominal rate for irrigation. In contrast, Eastern Indian plain having relatively abundant groundwater resources but diesel is the dominant available relatively at higher price. Private ownership of irrigation infrastructure and availability of cheaper source for irrigation (electricity) has led to sudden jump in irrigation infrastructure. It has improved agricultural production but it has repercussion on groundwater sustainability. The daunting task for government is to find balance between energy demand and it's pricing for sustainable use of groundwater in agriculture.

PP172: Stability and adaptability analysis of BRRI released aus varieties in different locations of Bangladesh
(Abstract Id: A6-8-021)

^aNiaz Md. Farhat Rahman, ^aMd. Abdullah Al Mamun, ^aRokib Ahmed,
^aMd. Ismail Hossain, ^aMd. Abdul Qayum, ^aMd. Abdullah Aziz, ^bMd.
Akram Hossain and ^aMd. Shahjahan Kabir

^aAgricultural Statistics, Bangladesh Rice Research Institute, Gazipur,
Bangladesh

^bClimate, Bangladesh Meteorological Department, Dhaka, Bangladesh
niaz.sust@gmail.com, mamun4777@gmail.com, rokib4u@gmail.com,
mihossain2@yahoo.com, aqstat.ru@gmail.com, rupom_ju@yahoo.com,
akram_hossain2011@yahoo.com, kabir.stat@gmail.com

The genotype by environment (G×E) interactions can be observed by differential genotypic responses to varied environmental conditions. Its effect is to limit the accuracy of yield estimates and complicate the identification of specific genotypes for specific environments. The frequently used model additive main effects and multiplicative interaction (AMMI) were used in this study to identify high yielding Aus rice varieties having wide adaptation and or specific adaptation to environment. Multi environment trials on eight Aus rice varieties were conducted at four environmental conditions in 2016. Genotype by environment (G×E) interactions contribution was much higher than the genotypic effect and environmental effect on grain yield. The genotypes BRRI dhan65, BRRI dhan48 and BRRI dhan43 display higher adaptability and stability. Therefore they are included in the study and recommended to be used in all environments. The variety BRRI dhan65 was identified as the

most suitable variety with wider adaptability in the region Kushtia followed by BRRI dhan48 and BRRI dhan43. Latest varieties performed better than the oldest ones based on grain yield and could be replaced through ensuring the supply chain of new promising varieties of that locality.

PP173: Plot-level variability in phytosociological and structural characterization of tropical herbaceous vegetation in West Africa
(Abstract Id: A7-9-007)

^aThiburce S. Bokossa, ^bAmadé Ouedraogo, ^aSylvanus Mensah, ^cArmand Natta and ^aRomain Glèlè Kakai

^aLaboratoire de Biomathématiques et d'Estimations Forestières, University of Abomey-Calavi, Abomey-Calavi, République du Bénin

^bDépartement de Biologie et Physiologie Végétales, Université de Ouagadougou, Ouagadougou, Burkina Faso

^cDépartement d'Aménagement et Gestion des Ressources Naturelles, University of Parakou, Parakou, République du Bénin

boksidoine@gmail.com, amadeouedraogo@gmail.com,
sylvanus.m89@gmail.com, armand.natta@gmail.com,
glele.romain@gmail.com

Primary floristic information on vegetation are often obtained from methods that solely rely on ground plots. Inventory plots patterns (size, shape and direction) have been identified as primary sources of uncertainty, as they influence the precision of estimation of vegetation parameters. In this study, we analyzed the plot-level variability in phytosociological structure for herbaceous vegetation in relation with inventory plots patterns. Using a phytosociological dataset collected from 11 plots of 1ha each, randomly established larger plots, we explored how different sets of plot shape, size and direction affect the structure of herbaceous vegetation in West Africa. Each 1 ha plot was divided into 400 quadrats of 25 m², and 28 possible types of subplots of different size, shape and direction were identified. The effect of subplot shape, size and direction was evaluated by modeling (i) the variation of the relative loss of accuracy in phytosociological characterization and (ii) the estimation error of herbaceous density. Both plot size and direction showed significant effects on phytosociological characterization of herbaceous vegetation, while plot shape did not. More specifically, the relative loss of accuracy decreased as plot size increased, square subplot of 625 m² (25 m x 25 m) was suggested as optimal in assessing phytosociological characterization of herbaceous vegetation. We also found that plot size and shape have a significant effects on the estimation error of the plant density. It was suggested that rectangular plot of 60 m x 20 m would be more efficient to accurately estimate the plant density of herbaceous vegetation.

PP174: Apparent digestibility and nitrogen utilization by red Sokoto goats fed brewer's dried grains and malted sorghum sprouts as complete diet
(Abstract Id: A7-9-008)

Nsidinanya Nnabuihe Okechi, Ezimoha Christiana Ogechi and Ibeawuchi John Anakwezie
Department of Animal Production and Livestock Management, Michael Okpara University of Agriculture, Umudike, Nigeria
no.nsidinanya@mouau.edu.ng, ezimoha.christi@gmail.com, jaibeawuchi@yahoo.com

Apparent digestibility and nitrogen utilization were evaluated using Red Sokoto (RS) goats fed brewer's dried grains (BDG) and malted sorghum sprouts (MSP) as complete diets. The experiment was laid out in a completely randomised design (CRD). Four (4) dietary treatments (T1, T2, T3 and

T4) were formulated to contain varying proportions of BDG and MSP in the ratios of 40:10, 30:20, 20:30 and 10:40 respectively with *Andropogon tectorum* (AT) as a grass hay meal fixed at 31% of the total diet in order to form complete diets. Twelve (12) intact RS bucks weighing between 12 and 15 kg were selected and transferred into separate metabolism crates. Three (3) bucks constituted a treatment with one (1) buck per replicate. Samples of the test ingredients, diets and faeces were analysed for proximate compositions and energy while the urine samples were analysed for urea nitrogen. The results showed that BDG, MSP and AT hay meal contained; 91.90, 89.72 and 91.34% dry matter (DM); 18.22, 23.20 and 13.27% crude protein (CP); 13.95, 9.62 and 26.90% crude fibre (CF); 3.92, 5.52 and 3.15% ether extract (EE); 45.46, 48.19 and 40.18% nitrogen free extract (NFE); 6.35, 3.19 and 7.84% ash and 1.72; 1.79 and 1.65 MJ/kg energy. Similarly, the diets; T1, T2, T3, T4 contained 15.60, 16.10, 16.59 and 17.09% CP and 1.66, 1.68, 1.68 and 1.70 MJ/kg energy respectively. Except for CF, all the nutrients evaluated for apparent digestibility showed statistical differences ($P < 0.05$). Increasing levels of MSP promoted higher CP and energy digestibility. Diets T1, T2, T3 and T4 recorded 75.23, 62.41; 82.55, 69.38; 85.50, 68.03 and 87.76, 68.54% for crude protein and energy digestibility respectively. The apparent nitrogen(N) utilization study showed that the mean body weight, dry matter intake (DMI), N-intake, absorbed-N and N-balance were statistically unaffected ($P > 0.05$) by the dietary treatments while DMI as % of live weight (LW), N in faeces, N in urine and apparent-N-digestibility varied statistically ($P < 0.05$). DMI as % of LW were 3.22, 2.61, 2.56 and 2.68 for T1, T2, T3 and T4 respectively. Faecal-N (g/d) values were; 3.15, 1.89, 1.65 and 1.57 while urine-N (g/d) were; 2.34, 2.14, 1.97 and 1.63 respectively for T1, T2, T3 and T4. All the animals were in positive nitrogen balance. It was concluded that the diets promoted the performance of RS bucks in respect to the parameters studied.

PP175: Livestock production statistics- Discussion on methods and outcomes
(Abstract Id: A12-13-007)

Ajith Kumar N

AHS division, Department of animal husbandry and Dairying, Ministry of Agriculture
and Farmers' Welfare, Government of India, New Delhi, India
ahslsc2018@gmail.com

India is endowed with over 512 million livestock population having genetically diversified classes of animals. It provides livelihood to over 70% of the rural population in our Country. Generally, livestock provides monetary support for rural households and act as a subsidiary income to most of the agricultural households in country. The ethnic and socio-cultural aspects of our country too holds good as reason for rearing or domesticating livestock. Since India is the largest milk producing country in the world, around 20% of total milk production in the world comes from India.

Considering the importance of this sector, it is necessary to have a sufficient data base back up on all relevant parameters in order to evolve various welfare measures for the livestock and livestock farmers. For planning and policy formulation at the Centre, India has adopted systematic practice of collection of information. For this, a well-structured Census and Survey are being carried out on regular basis. The Livestock Census is conducted in every five years provides the complete count of animals reared by each and every household in the country. The Census data becomes as a base data or auxiliary information for estimating the livestock production statistics such as milk, egg, meat and wool. The production of milk, egg, meat and wool in the country is estimated based on the result of Integrated Sample Survey which is conducted across the country in three seasons i.e. summer (March-June), Rainy, (July- October) and Winter (Nov-Feb). Based on the seasonal estimates, the annual estimates are derived. The State Department of Animal Husbandry is the nodal agency for implementation of the sample survey. The survey is conducted in two stages, (i) Complete Enumeration and (ii) Detailed Survey. The estimated population is arrived based on complete enumeration and the average yield is calculated based on detailed survey. □ The milk production has increased from 163.7 million tonnes in 2016-17 to 176.3 million tonnes in 2017-18 registering a

growth of 6.6%. □ Nearly 35% of the total milk production is contributed by Indigenous Buffaloes. The Indigenous cattle contribute 10% of the total milk production in the country. The annual growth rate shows a steady increase from the year 2013-14 and in the current year 2017-18. The largest producer of milk is Uttar Pradesh with 16.5% of the total milk production in the country. Uttar Pradesh being the largest Milk producing State has per capita availability of 359 gm/day. The world milk production stands at 828 million tonnes in the year 2017. India contributes over 176 million tonnes of milk production with contribution of 21.3%. The Countries like USA and China stands 2nd and 3rd position in the milk production. □ In case of India, there is consistent growth in milk production especially after 2014 the country's growth in milk production has reached over 6% and recorded as 6.6 % during 2017. India's share in the world milk production is showing consistent increase and stands at 21.3% during 2017.

PP176: Modeling Seasonal Growth of Tor Tor in Pond Environments
(Abstract Id: A7-9-001)

N Okendro Singh

Department of Basic Sciences, College of Agriculture, Central Agricultural University,
Imphal, Manipur, India
nosingh2000@yahoo.com

The present investigation attempts to determine the growth of Tor mahseer in seasonal environments of different ponds in Manipur by fitting of various nonlinear models and their modified forms. Gompertz model performed better than other models irrespective of different ponds when they were fitted to the growth data of Tor mahseer. A modified form of Gompertz model with sine wave function was finally adjust to be the best fitted model to the growth of Tor mahseer.

PP177: Adaptation strategies to climate change in sustainability of Indian agriculture:
An empirical analysis
(Abstract Id: A6-8-029b)

Saheli Das

Centre for International Trade and Development, Jawaharlal Nehru University, New
Delhi, India,
sahelidas.2008@gmail.com

This research work is mainly based on the inextricable relationship between agriculture and climate change. Agriculture is one of the most climate- sensitive sector in the economy and India ranks as the second most climate-vulnerable country in the world with respect to extreme weather events according to the Climate Change Vulnerability Index (CCVI) (Maplecroft, 2011). Recent trends in India point towards declining agricultural productivity, even in the face of technological progress and policy impetus. Productivity of Indian agriculture is under threat from resource constraints, such as scarcity of land and water, soil degradation, and climate change-induced temperature increases and rainfall variability (Economic Survey, 2018), i.e., declining productivity is largely on account of depleting natural resources and environmental change (Chand et al., 2007). Due to less access to formal education and poverty trap, farmers often face challenges to adopt any sudden or continuous climate change along with climate-sensitive technological change. As a result of these less formal education and training of farmers, in a world of skill-biased technological progress, Indian agriculture tends to lose out in yields. However, farming communities display coping mechanisms through the knowledge gathered from their ancestors, i.e., the traditional knowledge and from other known people within their own networking, and thus able to serve almost half of the population of India by producing food grains. In this research, we will focus on the relationship between agricultural production (for rice/wheat) and climate variations while controlling other variables such as

availability of natural resources, technology, public- private infrastructure, government support, socio-economic factors and weather shocks. In this study, district level analysis has been done for the time period 1980-2019 (subject to data availability). Using panel data econometric tools, this study will show how adaptation through different channels help the key players of agricultural sector, i.e., the farmers to improve their wellness and thus to promote sustainable economic growth.

PP178: Agricultural land-use systems and climate change among small farmers in Sub-Saharan Africa: Relationship and evidence of adaptive processes in Nigeria
(Abstract Id: A8-10-012)

^aTemidayo Gabriel Apata, ^aSunday Ogunjimi, ^bYapo N'guessan, ^aAdetunji Kehinde,
^cMobolaji Okanlawon, ^aOluwaseun Bamigboye, ^aChristopher Adara, ^aOlutope Ojo and
^dOlanrewaju Omoju

^aAgricultural Economics and Extension, Federal University Oye-Ekiti, ikole, Nigeria

^bEconomics and Business Administration, Jean Lorougnon Guede University, BP 150
Daloa, Cote d'Ivoire., Daloa, Cote D'Ivoire

^cProduction Technology, Institute of Agricultural Research and Training, Ilorin, Ilorin,
Nigeria

^dSoil Science and Land Management, Federal University Oye-Ekiti, Oye Ekiti, Nigeria
dayo.apata@fuoye.edu.ng, Sunday.ogunjimi@fuoye.edu.ng,
nguessanyapo@hotmail.com, tjgreenk@gmail.com, mobolaji.mm@gmail.com,
oluwaseuntosin90@gmail.com, chrisbabafarm@gmail.com, topeojo7777@gmail.com
and olanrewaju.omoju@fuoye.edu.ng

In most of sub-Saharan-Africa (SSA), agriculture land-use supports the livelihoods of the majority of people. Land-use for agricultural-activity is an economic activity that is highly dependent upon weather and climate that produce food and fibre necessary to sustain human life. Hence, land-use for agriculture is expected to be vulnerable to climate change. This study examines how climate change affects agricultural land-use and how such land-use contributes to climate change. The study elaborates on what aspects of “climate change” that is impacting the country agriculture like global warming, higher/lower precipitation rates and frequent extreme events. Multi-stage sampling technique was engaged for national data collection of 1200 farmers desirable for study objectives realization. Data on socioeconomic and environmental attributes, information on farmers’ perceptions of climate change and adaptation methods were collected. Farmers were specifically asked to respond to questions on patterns of change in temperature and rainfall over the past 20 years and its influence on their agricultural production. Temperature and rainfall data were obtained from monthly/annually meteorological weather-related data. Data were analyzed using Descriptive Statistics and Cross-tabular analysis of significant variables and Trans-logarithmic-model (TLM) that generated short-run sustainability-index (SRSI) used as an index of land-use management. TLM coefficients results revealed SRSI, land policy-intervention variables and household-sizes are dominance factors for land-use climate change interaction. Also, SRSI recorded 0.69, suggesting that 69% of the farmers made unsustainable use of agricultural land. Marginal Value Product (MVP) model was used as adaptation factors determinants and was tested for its appropriateness which gave a robust estimation. The estimated correlation coefficients among the various adaptation options are significant for 10 out of 19 combinations. While climate-change is acknowledged as an existential threat, policies or mechanisms in place to guide climate-induced agriculture poor/non-existence. Smallholder farmers in SSA produce below the optimal levels with considerable yield gaps largely due to poor land-use management. Sustainable land-use management needs to be entrenched to curtail the threat of climate change. Strategic and systemic implementation of options that yield multiple benefits such as climate-smart agriculture should be implemented. Further, investing in the development of sustainable-functional early and early- warning systems and valuable insights on policy-requirements to reduce farmer vulnerability to climate-change.

PP179: Application of support vector machine and geostatistical tools to estimate above ground biomass using spectral reflectance indices
(Abstract Id: A8-10-031)

^aDibyendu Deb, ^bShovik Deb, ^cJ P Singh, ^dDebashis Chakraborty and ^eAmit K Singh

^aAgricultural Statistics, ICAR-IGFRI, Jhansi, India

^bSoil Science, UBKV, CoochBehar, India

^cGeography, ICAR-IGFRI, Jhansi, India

^dAgricultural Physics, ICAR-IARI, Delhi, India

^eAgricultural Meteorology, ICAR-IGFRI, Jhansi, India

Vegetation indices (VI) are long known to be a good indicator of the condition of vegetation such as nutrient status, health and vigour, production etc. VIs become more of a necessary tool to estimate Above Ground Biomass (AGB) of a vast area comprising different vegetation classes. The present study attempts to find out the most suitable VI amongst some most popular one and the most precise model for site-specific AGB estimation for an area located at semi-arid region of India known as Bundelkhand. Five VIs namely SAVI, EVI, EVI2, MSAVI and NDVI were selected for the study of which EVI showed the highest correlation with all classes of vegetation and also proved to be suitable support vector for differentiating vegetation classes. Multiple linear regression using all the VIs for different vegetation classes gave good fit for few of them. As EVI was the VI with highest correlation, so nonlinear model (exponential) was attempted and though its fit was not as good as multiple for overall vegetation yet for particular vegetation classes its result was better than the previous one. A machine learning technique called support vector machine was then used for AGB estimation using EVI as support vector and provided AGB estimation with far better accuracy compared to traditional regression approach. All the regression models were compared using several goodness of fit statistics. Further the best VI and the best AGB estimation technique were used to calculate AGB of all the sample locations used as ground control points across the study area. Finally these estimated AGB for all scattered locations were subjected to Geostatistical interpolation tool kriging to create a continuous surface for AGB production estimation.

PP180: Climate change and infectious diseases: Case of Malaria prevalence in Togo
(Abstract Id: A8-10-009)

Etayibtalnam Koudjom

Economics, University of Lomé, Lomé, Togo

emmakoudjom@gmail.com, emaklesso@gmail.com

The main objective of this paper is to explore the effect of climate change on infectious diseases. Specifically, it aims to assess the economic impact of climate change on malaria prevalence in Togo. To achieve this objective, we use data from the "Questionnaire of Basic Welfare Indicators (QUIBB)" survey conducted in 2015 by the National Institute of Statistics and Economic and Demographic Studies (INSED-Togo) on 2335 households representing the Togolese population at the national level. Using semi-parametric and contingent valuation methods, the following results were found. On the one hand, the number of malaria cases is increasing due to climate change at average monthly temperatures of 27°C and 29°C, an increase of 2°C. On the other hand, the willingness to pay of malaria-affected patients is increasing by an amount of 1857,384 CFA francs per individual per year to reduce malaria cases due to climate change. This amount represents the excess of the average annual cost of malaria treatment related to climate change. In accordance with the results, the Togolese authorities can take certain measures, such as cleaning breeding sites, killing mosquito populations, educating people, to reduce the likelihood that people will be infected with malaria.

**PP181: Mapping and Analysis of Soil Fertility Using Remote Sensing and GIS
Technology
(Abstract Id: A8-10-001)**

^aRavi Kumar Meena, ^bHema Meena, ^cBabu Lal Meena, and ^dM L Meena

^aSoil Science and Agricultural Chemistry, College of Agriculture Lalsot, Dausa,
Rajasthan

^bSample Survey, ICAR-IASRI, New Delhi

^cAgronomy, College of Agriculture Lalsot, Dausa, Rajasthan

^dPlant Pathology, College of Agriculture Lalsot, Dausa, Rajasthan

rkmeena.soils@sknau.ac.in, hema.mpuat@gmail.com, rkmeena.soils@sknau.ac.in,
rkmeena.soils@sknau.ac.in

Recent assessments of the ecosystem functions of soils and their importance for global sustainability underscore the importance of the management of soil resources for different land uses for present and future societal welfare (Adeel et al, 2005). Soil quality (SQ) is considered to be a key element of sustainable soil function. Soil quality is the capacity of a specific kind of soil to function within ecosystem and land-use boundaries, to sustain biological productivity, maintain environmental quality, and sustain plant, animal and human growth. (Doran and Parkin., 1994). Soil quality involves physical, biological, and chemical attributes that are merged together to indicate soil functioning (Andrews et al, 2002). Monitoring SQI at large spatial scales remains expensive, as well as time and labor consuming, when using the standard procedures due to the large number of soil analyses involved. Soil quality mapping requires the integrated consideration of key soil properties and their variations in space and time. The developments of SQ maps with complete area coverage are needed for addressing climate change, land degradation, and hydrological processes in global and regional models and management of soil resources for sustainable agricultural production. However, currently only a few spatially exhaustive datasets are available for assessment of soil quality. Remote sensing and GIS may offer possibilities for monitoring SQ at spatial scales relevant for modeling or management. Airborne imaging spectroscopy (IS) is an advanced tool for studying natural and artificial materials, in general, and soil properties, in particular because of their unique spectral signature. Tarin Paz-Kagan et al. (2015) demonstrated the ability of IS to evaluate soil properties and quality across anthropogenically induced land-use changes. They developed a spectral soil quality index (SSQI) using IS obtained by a laboratory and field spectrometer (point scale) as well as by airborne hyperspectral imaging (local scale), in two experimental sites located in Israel and Germany. In this regard, 13 soil physical, biological, and chemical properties and their derived soil quality index (SQI) were measured. Several mathematical/statistical procedures, consisting of a series of operations, including a principal component analysis (PCA), a partial least squares-regression (PLS-R), and a partial least squares-discriminate analysis (PLS-DA), were used. The PLS-DA model that was used to develop the SSQI showed high classification accuracy. Productivity rating systems are also important tools to quantitatively assess soil health. In precision farming such information is required for planning appropriate soil and crop management strategies at spatial scale. Amirinejad et al.(2011) developed a procedure for assessing the soil physical health of a farm under rice-wheat cropping system in Uttar Pradesh. Spatial variability analysis of soil physical properties measured on a rectangular grid (30 m×45 m) was carried out by using geostatistical analyst extension of Arc GIS software. Correlations between PI (physical health index) and grain yield of both wheat and rice were fairly good ($r^2=0.67$). The results thus supported earlier findings that good soil physical health is essential for optimum sustained crop production. Spectroscopy is a rapid, non-destructive, reproducible, and cost-effective analytical method for assessing SSQI.

**PP182: Save water save life
(Abstract Id: A8-10-032)**

Bhakta Bihari Mishra
NGO, National Integrated Human And Industrial Development Agency(NIHIDA)
Odisha, Nimapada, India
nihidavo@gmail.com

Three-fourth of Earth's surface is covered by water bodies. 97 per cent of this water is present in oceans as salt water and is unfit for human consumption. Fresh water accounts for only about 2.7 per cent. Nearly 70 per cent of this occurs as ice sheets and glaciers in Antarctica and other inaccessible places. Only one per cent of fresh water is available and fit for human use. So it is very important to conserve this precious resource. And yet we are contaminating the existing water resources with sewage, toxic chemicals and other wastes. Increasing population and rapid urbanization has led to over-use of water resources leading to water pollution and scarcity. Water scarcity can be defined as a situation when people don't have enough water to fulfil their basic needs. India is one of the many countries that are facing water scarcity today. In Rajasthan and some parts of Gujarat, women have to cover long distances on foot in order to get a pot of water. In cities like Bangalore, a family has to spend from Rs. 15 to Rs. 20 to meet their daily water needs. The problem becomes severe during summer months when availability of water decreases again. A recent study has revealed that about 25 per cent of urban population lack the accessibility to fresh water. Also there are several cases of privatization of water bodies. This often leads to water scarcity in the nearby areas. There are different methods to deal with water scarcity. Rain water harvesting is the best and most suitable method. Forest and other vegetation cover reduce surface runoff and recharge ground water. So, practice afforestation. We can also promote water conservation through media and by conducting public awareness programmes. By practicing these simple steps we can conserve water and ensure the availability of water to future generations. So don't tarry; start saving each and every drop of water. Let our motto be "Save water, save life, save the world".

PP183: Management of rural water supply for human consumption in the open access regime in Lesotho
(Abstract Id: A8-10-008)

Ikhothatseng Jacob Greffiths and Eric Dada Mungatana
Department of Agricultural Economics, Extension and Rural Development, CEEPA
(University of Pretoria), Pretoria, South Africa, Jacobgreffiths@gmail.com and
ericmungatana@gmail.com

Water scarcity is globally recognised as a critical problem that significantly impacts negatively on the welfare of people of which rural population is more vulnerable. This study investigates the price of water for human consumption in the rural area of Qholaqhoe in Lesotho using the sample size of 199 rural households split into three parts of the water pricing bids (66 for M1.00, 66 for M1.50 and 67 for M2.00). The study used double- bounded bid elicitation format to test whether the three pre-determined starting price bids (M1.00, M1.50 & M2.00) has influence on the households' WTP for improved rural water supply. This contingent valuation study used the purposive and random sampling methods to conduct household in- person interviews (survey) in Qholaqhoe community. The two double bounded models were used to determine the impact of socio-economic characteristics, level of knowledge, attitudes and perception on rural households' WTP. The first double bounded model was econometrically estimated without the aforementioned covariates and yielded a mean WTP of M1.68 per 20 litres jerry can of water. The unrestricted double bounded model with the covariates yielded the mean WTP of M2.17 per 20 litre jerry can (LB M1.46 and UB M2.41) for improved water supply. The results of the unrestricted model show that WTP was positively related to

the following variables: household income, gender, household size, level of knowledge about water shortage health related risks, perception towards weekly water availability and type of employment. WTP was found to be negatively related to distance from water source. From secondary data, the study realised that the price of water per 20 litres jerry can is M1.50 hence three recommendations follow: First, the government through Lesotho Water and Sewage Authority (WASA) should consider instituting a policy that charges rural water consumption for improved reliable water supply. Secondly, the Water and Sewage Authority (WASA) through consultation with relevant stakeholders should consider charging rural household water consumption by pricing water between LB M1.46 and UB M2.41 per 20 litre jerry can to invest in rural water supply. Lastly, the government should consider socio-economic status of the household before pricing water.

PP184: Scope effects in contingent valuation: an application to the valuation of irrigation water quality improvements in Infulene Valley, Mozambique
(Abstract Id: A8-10-010)

Graça Manjate
Agricultural Economics, Extension and Rural Development, University of Pretoria,
Pretoria, South Africa
gracamanjate@gmail.com

This study uses the double-bounded bid elicitation format to test whether the willingness to pay (WTP) of 244 randomly selected residents of Maputo and Matola cities for wastewater quality improvements in the Infulene Valley is sensitive to internal and external scope. The Infulene Valley was selected because its wastewater is used as an input in vegetable irrigation. WTP was elicited and compared when the level of wastewater treatment was 100 % and when it was 50 %. The results show that the majority of those interviewed display high levels of knowledge and positive attitudes towards recycled wastewater reuse, and that they have attitudes and perceptions receptive to a policy that aims to improve irrigation water quality. The WTP responses passed the bottom up ($t=15.28$, $p=0.000$) and top down ($t=14.07$, $p=0.000$) internal and external ($t=13.43$, $p=0.000$) scope tests, suggesting that the level of wastewater treatment significantly influences households' WTP. The following variables were statistically significant in the WTP model: income, age, education level, household size, gender, whether the household considers water scarcity as a priority issue, knowledge of the unsuitability of Infulene Valley water for vegetable irrigation, and whether the household is aware that the Infulene Valley is an important supplier of fresh vegetables to Maputo and Matola residents. The study concluded that the level of water treatment (high quality of treated wastewater) is a significant factor of preference over the alternative policy in wastewater treatment. The following recommendations derive from the study: policy makers should consider wastewater treatment planning and they should develop an irrigation water pricing system, as well as conservation practices to manage pollution problems at Infulene Valley. While this study provides an estimate of household values for irrigation water quality improvements in the Infulene Valley, is ultimately up to policy makers at the city and country levels to implement any changes.

PP185: Impact of migration in agriculturally under-modernized and modernized village: A statistical aspects
(Abstract Id: A10-11-001)

S.R.J. Singh
Department of Statistics, RVSKVV, College of Agriculture, Sehore, India
srjsagcr@rediffmail.com, srjsagcr@rediffmail.com

The dynamic structure of social phenomena has been recently occupied a considerable place in the

minds of social scientists, planners administrators and researchers for a thorough understanding of the mechanism of migration process of farmers from rural areas. The changing status of farmers from under – modernized and modernized villages due to migration is a problem of social mobility. In the present paper an efforts is made to study the impact of migration to understand the trends and causes of migration in agriculturally under modernized and modernized villages. The study was conducted in Raipur block of Rewa district of M.P. It was observed that migration & more in under modernized village (51.43%) than the modernized villages. Highest number of migrants are from marginal farm in both modernized (53%) and under modernized (50%) villages. It is inferred that all the factors considered had a bearing on migration in under modernized regions where as only environmental and miscellaneous factors had maximum effect on migration in modernized villages.

PP186: Logistic regression approach for determining the factors responsible of internal migration in Somalia
(Abstract Id: A9-14-005)

^aMohamed Abdinur Mohamed and ^bK.K.Saxena

^aDirectorate of National Statistics, Mogadishu, Somalia

^bDepartment of Statistics, University of Dodoma, Dodoma, Tanzania

mabdinur330@gmail.com, saxkk@yahoo.com

Migration has been one of the most important economic and social phenomena of transition. Internal migration has become an inevitable process today, which includes all age groups of the population and there is no control to avoid its treatment. From a demographic perspective, migration is one of the main reasons for numerical changes (increase or decrease) of the population of a region or country, while being simultaneously an indication of social change. This study aims to examine factors of internal migration of population in Somalia. We made an attempt to analyze factors affecting internal migration of population on the basis of secondary data from a cross-sectional population estimation survey conducted in 2014 in Somalia on internal migrant households. Variables as age, sex, education, employment status, marital status, land ownership and reasons for migration of respondents, who participated in migration, were taken for the analysis for determining of factors leading to migration. The logistic regression model was used to compute influence of factors affecting participation of population in internal migration. The study found that education had an effect on migration. The rural resident households with no education background, were significantly more likely to migrate. Unemployment was another important significant factor for migration from rural to urban places. Sex and land ownership were not significantly associated with internal migration. Therefore, there is a need to improve the socioeconomic status of the households in respect of education and employment to reduce the incidence or prevalence of internal migration. We have concluded that migrants mainly participated rural-urban migration. Migrants were mainly economic migrants, who moved to seek jobs and to improve their living conditions. Disparities in population, social and economic characteristics affected rural-urban migration of population. Internal migration is a selective process based on demographic and socio-economic characteristics of migrants in Somalia.

PP187: Perception of Pradhan Mantri Kisan Samman Nidhi Among the Farmers of Uttar Pradesh
(Abstract Id: A9-14-001)

Netra Pal Singh

Department of Information Management, Management Development Institute, Gurgaon,
India

knpsingh@mdi.ac.in

Government of India announced that poor farmers will receive a cash incentive of Rs. 6,000 per year

from the fiscal 2018-19 and has cost Rs 20,000 crores to the Government. This scheme will cost Rs. 75,000 crores per year from the fiscal 2019-20 onwards. It will impact 12 crore small and marginal farmers. The money will be credited in their bank accounts in three equal instalments in a year. The eligibility for the scheme, will be ownership of less than 2 hectares of cultivable land. It is certainly a welcome step by the Government of India. However, it is also subject to criticism by political parties in and outside the parliament. Like any other scheme of government, it needs feedback from the ultimate beneficiaries. This study is an attempt to fulfill this objective by ascertaining the perception of beneficiaries with respect to many facets of the scheme such as adequacy of amount of incentive, continuity of the scheme for the next five years, next 15 years or till they are alive, ease of inclusion of their name as beneficiary, mode of payment and its benefits, usage of incentive money, impact of the scheme on their social status, and having feeling of inclusive growth vision of government. In addition, data is getting collected on demographics of the beneficiaries such as age, sex, educational qualification, land holdings, number of dependents, number of milking and non-milking animals, subsidiary activities such tailoring, carpentry, selling fruit & vegetables, selling construction materials, buying and selling of agriculture inputs and produces, part of other government scheme, pensioners, etc. to identify variations in the perception among different groups of beneficiaries. The respondents of data are about 400 beneficiaries of two districts of western Uttar Pradesh, i.e., Aligarh and Bulandsahar. The data is collected using a semi structured questionnaire. It is an ongoing project and will be completed in the next two months.

PP188: Banana losses and recovery in Thailand
(Abstract Id: A11-12-006)

Charuwan Bangwaek
Department of Agriculture, Ministry of Agriculture and Cooperatives, Bangkok,
Thailand
charuwanb38@gmail.com

Kluai Hom and Kluai Khai which are 2 kinds of banana, were export to Japan and the Republic of China, respective, raising the economy in Thailand. Meanwhile, some banana was not under-graded then getting much lower prices in local markets. Losses in banana, var. Kluai HOM was found in all steps along supply chains especially harvesting (about 1.3%), storage (about 3.19%), Postharvest management (about 10.16%).

Losses occurred by cutting, bruising from the strong handle, fungi after getting a scar, ununiform ripening, et al. In Kluai Khai, the same damages occurred in similar causes, losses were found are 43.30% on harvesting and 47.39% on postharvest management, 64.19% on the shelf. However, appropriated postharvest technology, such as suitable harvesting time, soft and clean handle, appropriated storage condition, transportation, Appropriated harvesting time depended on purposes, such as 70-80% of maturity for export, 90% of maturity for processing. Soft and clean for cutting and washing, removing disease and attached insect and modifies atmosphere in packaging. To reduce losses such as bruise from the strong handle, protection from disease was done by good practices or approved chemicals. Low temperature (13-14oC) to prolong storage and shelf life were treated.

PP189: Measurement of returns of agricultural investments in India
(Abstract Id: A11-12-002)

Mukesh and Kamal Pandey
Government of India, National Sample Survey Office, New Delhi, India
mukesh.iss.goi@gmail.com and kamalpandey.iss@gmail.com

Government investment in different sectors of economy is mainly aimed at enhancing its productivity. The objective is to create a conducive environment of growth in economy, so that the sectors achieve self-sustainability. India as a developing country has been working on this principle for long and has attempted to get maximum returns of investments from each sector. However returns in the agricultural sector have been particularly grim. The contribution of agricultural sector in economy has been declining over the last decade despite the fact that the employment in the sector continues to be the highest. The one possible reason may be decline in focused importance of the agriculture sector relative to other sectors. Public sector investment in agricultural sector gives potential to improved food production capacity of country, reduced inequalities, inclusive growth and creation of jobs. Accordingly Government of India has increased investment through enhanced international cooperation in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productivity capacity. So, with this huge investment in agricultural sector, it has become important to estimate the returns of agricultural investment. The measurement of return of agricultural investments is possible with in-depth analysis of data on investment and GDP. This paper is about the measurement of returns of agricultural investment in India in terms of increased productivity. For this an attempt has been made to calculate the Agricultural Orientation Index (AOI) which is the agriculture share of government expenditures divided by the agriculture share of GDP. Agriculture share of Government expenditures means central Government expenditures on agriculture relative to total central Government outlays in the given financial year. Agriculture share of GDP means agriculture value added in relation to gross value added in the entire economy during the particular financial year. If the value of AOI is greater than 1, then this means the agriculture sector receives a higher return of government investment relative to its economic value and when AOI is less than 1, this reflects a lower return to agricultural Investment. The analysis has been done over the years starting from 2011-12 to 2017-18 to have long term measurement of India's return on agricultural investment. Further an attempt has been made to find out the return on investment of particular sub-sectors of agriculture within the agricultural sectors of India (like Crops, Livestock, Forestry and Fishery). The idea is to identify the sub-sectors yielding maximum returns on investment, so that due diligence and careful attention can be ensured to that particular sub-sector of Indian agricultural system.

PP190: Statistical and attitudinal challenges for well-being, holistic development and SDG

(Abstract Id: A11-12-001)

Sheela Misra

Department of Statistics, University of Lucknow, Uttar Pradesh, India
 profsheelamisra@gmail.com

It is not possible for any individual or nation to be happy and prosperous if someone or some part of the world is deprived of their dues or lacks humanity, sustainability and development. Inclusive development is must for harmonious and peaceful coexistence. To ensure this United Nation has set an agenda in the form of Sustainable Development Goals (SDG-2030) for making world a better place leaving no one behind. To achieve the set targets different statistical tools, techniques, methodologies and indicators are used to continuously monitor the situation so that appropriate action can be taken immediately as and when needed. In this paper we critically discuss the appropriateness and impact of some of these methodologies and indicators and their conclusions from technical, practical, social, cultural, attitudinal and behavioral point of view and their impact on humanity and holistic development. The objective is to come up with unidentified perspectives, factors and their impact with possible solutions wherever needed in the interest of whole humanity and complete well being. These issues are highly relevant to Statistics for transformation in general and agriculture in particular along the lines of the of the conference "Statistics for transformation of agriculture to achieve Sustainable Development Goals. The deliberations on this are expected to come out with the solutions for policy makers to approach the targets through best possible statistical

and social strategies and techniques.

PP191: The possibilities and challenges to address the food and agriculture related SDG indicators in upcoming national agriculture census of Nepal
(Abstract Id: A11-12-012)

Nirajan Sharma

Central Bureau of Statistics, Government of Nepal, Kathmandu, Nepal
sharmanirajan99@yahoo.com

Among the 232 SDGs indicators FAO recognizes 21 indicators are solely depends upon food and agriculture and 4 indicators are also supported by agriculture. Nepal's food and agriculture data needs to monitor the 17 indicators of SDGs while the 4 indicators are not related to land locked countries like Nepal. Nepal is committed to pursuing and achieving SDGs by 2030. The periodic plans and annual budgets have already begun to reorient policy and budget priorities to reflect these commitments. But there is a huge data gap to monitor the SDGs indicators, especially for the food and agriculture related indicators in Nepal. Data related to hunger, severity of food insecurity, production of small scale food producers, public investment in agriculture, food price volatility, forest area and sustainable forest management are provided by Central Bureau of Statistics (CBS), Ministry of Agriculture and livestock, Ministry of Finance, Ministry of forest and Environment through various surveys and censuses, administrative data and government finance statistics of Nepal. However, the data related to agriculture sustainability, conservation of plant and animal genetic resources, risk status of livestock breeds, women's ownership of agriculture land, women's equal rights to land ownership, water use efficiency, sustainability of water resources, food losses, green cover index, disaster economic loss, land degradation and the fair and equitable sharing as the benefits arising out of their use are mostly not available to monitor the respective SDG indicators in Nepal. The national census of agriculture is the main source of basic agriculture statistics for agriculture policy planning and development. The census could also serve as a main source of agriculture statistics for SDG monitoring related to food and agriculture as mentioned by the FAO if necessary questions are included. Nepal has a long history of undertaking agriculture census since 1962 in every ten years and the next agriculture census is planned for 2022. The CBS Nepal has scheduled the preparation of questionnaire and data collection tools from early 2020. This is a right time and has great opportunity to address the data gap issues for monitoring food and agriculture related SDG indicators, if appropriate census planning and questionnaire is designed on time. In this context, this paper aims to analyze the possibilities and challenges in addressing SDG indicators related to food and agriculture in upcoming National Sample Census of Agriculture of Nepal in 2022. The SDG metadata repository for the indicators, the FAO guidelines for the World Programme for the Census of Agriculture 2020 (WCA 2020), and the past agriculture surveys and censuses of Nepal will be reviewed for developing appropriate questionnaire and it will also analyze the limitations and challenges in acquiring the required information for the SDG indicators from the agriculture census. The findings from the paper will be very helpful to costing and designing an appropriate questionnaire for upcoming agriculture census in Nepal in considering the food and agriculture related SDG indicators.

PP192: An Analysis of Poverty in Rural Sector in Punjab
(Abstract Id: A12-13-004)

Shilpi Kapoor

Department of Economics, Lovely Professional University, Ludhiana, Punjab, India
shilpikapoor39@gmail.com

The official attention of various policymakers revolves around the reduction of rural poverty. High growth is not the enough consideration but the pattern and sources of growth and the procedure in

which its benefits are distributed are equivalent important for reduction of poverty. The inequality in income and poverty has been rising in both rural and urban areas in India (Himanshu, 2008). The consensus in the literature is that higher growth rates tend to yield more rapid rates of absolute poverty reduction (Ravallion 2001). With a population of over 1.2 billion India is home to the largest number of poor in the world. About 42 per cent of the Indian population lives under the global poverty line of \$1.25 per day (Rangarajan, 2014). The percentage of population living below the poverty line in Punjab was 7.7 per cent in rural areas and 9.2 per cent in urban areas in 2011-12 in comparison to 14.6 per cent in rural areas and 18.1 per cent in urban areas in 2009-2010 (NSS various rounds). The rural non-farm sector in Punjab may not only enhance household incomes, thereby alleviating the household poverty, but may also reduce the income gap between the poor and the rich to pave the way for a more equitable growth (Vatta & Sidhu, 2010). The study also found that the incidence of rural poverty was significantly influenced by the operational land, caste, workers' education, WPR and casual wage labour as the major source of income in Punjab. Farm incomes declined sharply at the rate of 8.5 per cent per annum (at 1993-94 prices) during 1999-2000 to 2004-05, causing a simultaneous increase in rural poverty from 6.2 per cent to 8.4 per during this period (Joshi et al., 2007). Based on the gaps found in the literature, the present study will analyse the trends and patterns of rural poverty in various districts of Punjab. It will also investigate the determinants of poverty in rural sector in Punjab. This study will be based on unit level consumption expenditure data of NSS from 1993-94 to 2011-12 and the upcoming data as well. Logistic regression analysis will be performed to determine which factors are most important in distinguishing the poor from the non-poor as per Silva (2008). Thus, a critical evaluation of poverty levels as well as its associated determinants bearing in mind both the incidence as well as the depth of poverty of districts would help re-orientate interventions on poverty and enhances the effectiveness of poverty reduction strategies.

**PP193: Changing trend in India's agricultural trade and the impact of liberalization on
India's agricultural trade
(Abstract Id: A12-13-013)**

Rashmi Chaudhary
IBS, ICFAI University, Dehradun, India
irashmi23@rediffmail.com

Changing Trend in India's Agricultural Trade and the Impact of Liberalization on India's Agricultural Trade Dr. Rashmi Chaudhary Assistant Professor ICFAI University Dehradun Uttarakhand, India irashmi23@rediffmail.com Abstract India has been a reasonably conservative player for long. In the period after Independence, it was felt that exposure to the world agri-markets had the potential to affect the prices of agricultural products (most important being food) in the negative way. Thus most agrarian economies like, India tried to control agri-trade and in this process, tried keeping agricultural sector's external vulnerability low. Further in India more than 70 percent of the employment occurred from the agriculture and hence it was feared that any exposure to trade would jeopardize the livelihoods of many people. In any case it was not easy to penetrate the developed country's markets which were and continue to be fairly protectionist. The planning process in India has been found guilty of neglecting the foreign trade sector in general and agri-trade in particular. The emphasis, in the second five year plan was laid on manufacturing sector. Within the trade sector, too, traditional i.e., agricultural exports were neglected by India. Exports promotion efforts were exclusively concentrated on non- traditional exports of manufactures, while most traditional exports were neglected. Very little was done to prevent or slow down the decline in India's relative share in the world market for the major traditional exports. In fact the combination of trade policies actually employed and added a positive discrimination against them. When campaign was started by the developed countries, having agricultural surpluses, for inclusion of agriculture in GATT, many of the developing countries like India saw an opportunity in liberalizing agri-trade as they felt that they had comparative cost advantage in case of some crops due to weather conditions or low labour cost. Though the perception of high risk in agri-trade continued, agri- trade also seemed to offer a prospect

for increasing employment and income. It was felt that agriculture too, could avail of advantages which the manufacturing sector gets due to liberalization; slowly the idea that we should produce for exports started gaining ground. In 1991, as a response to the external sector crisis, the liberalization got an impetus. In 1995, India signed the WTO and became a part of the Agreement on Agriculture (AoA). Later over the years, more policy measures were introduced which removed the quantitative restrictions on agricultural imports, the role of canalizing for imports was reduced but licensing for many agricultural exports continued. Non-tariff barriers were converted into tariff barriers. There was also a large scale withdrawal of export incentive schemes. Over a period of time, India has had to open up its agricultural sector and allow more imports. However, even in a more liberalized environment, India has basically followed the policy of allowing imports when domestic production has fallen short of the demand. The purpose of the present study is to see the changing trend in India's agricultural trade and thereby analyze the impact of liberalization on India's agricultural trade.

**PP194: Confusion matrix-based selection of hexa-orfs of gene-cds with mutability of central codon
(Abstract Id: A12-13-029)**

^aM Balakrishnan, ^aS.K. Soam ^aPraharshit Sharma ^aK. Sumalatha and ^bCh. Srinivasa Rao

^aICM Division, ICAR-NAARM, Hyderabad, India

^bDirector, ICAR-NAARM, Hyderabad, India

mbkrishnan@hotmail.com, soam@naarm.org.in, praharshit.sharma@gmail.com,
suma.katta326@gmail.com, cherukumalli2011@gmail.com

This study includes a modern tool for feature selection and elucidates it on a real data set with the entire Phylogeny of Tomato gene, AY573802, and alpha-numerically substitute cyclically for TP/True +ve, TN/ True -ve, FP/ False +ve, FN/False -ve; the 4 nucleotides A|C|G|T such that "Confusion matrix parameters" namely 24 values Each (since $4! = 4 \times 3 \times 2 \times 1 = 24$), pertaining to Sensitivity/ True+ive rate, Specificity/ True -ve rate, Precision, Recall, Miss rate, Fall out, False Discovery& Omission rate, Classification accuracy, Error rate, F1- and Fr- scores, MCC/ Mathews Correlation Coefficient, Markedness, Youden's index, Balanced Classification rate and Discriminant Power Normalized Likelihood index – by blastx of Gene above. Now, the SIX-ORFs/ Open Reading Frames of the CDS of All blastx Hits (e-Value <0.005), are considered (+1, +2, +3 and -1, -2, -3) and Central Condon nucleotide is systematically point mutated across [A, C, G, T] so we Obtain $6 \times 4 = 24$ candidate Peptide sequences/ Protein Primary structures. This is because Central codon nt/ mutation most likely "alters" the Amino-acid translated itself, per Trinucleotide (except Serine). Subsequently, the peptide sequences thus Obtained are "encoded" as per their Side-chain based Classification: aciDic (D), Basic (B), Polar (P) and Non-polar (N). For instance, the "cds" ATGATTACATAG -> ATG – ATT – ACA – TAG -> Met-Ile- Thr -> N-N-P. Similarly, mutating "central" Codon nt generates 24 distinct "aa" Classification-based patterns. Now, a "Correlation analysis" (3:1 scaling Ratio) of the A|C|G|T- CDS level "24" elemental Set each of the various Confusion matrix parameters are computed; is performed with the corresponding B| D| N|P- level peptide Sequences, which are also "24" arising out of 6ORF X 4central Codon-nt=24 Finally, aligning well with the tri-Ennial. We further proceed toward "Ternary plot Visualization" of the Nutritional Agriculture aspects of the peptides so translated, for instance same as with Tomato phylogeny as discussed above. The encoding in this case being NEAA for "Non-Essential Amino acids", CEAA for "Conditionally Essential Amino Acids" and EAA for "Essential Amino Acids" respectively. A sample Ternary plot: This present study discussed with the large volume of data set and the machine learning it can be used to explore the version space. It can be extrapolating this method to multiple data sets and investigate its scalability factor.

PP195: Construction of two level balanced and nearly balanced optimal supersaturated designs

(Abstract Id: A12-13-022)

Anurup Majumder, Parvez Mallick, Jit Sankar Basak, Ankita Dutta
Department of Agricultural Statistics, Bidhan Chandra Krishi Viswavidyalaya, Kolkata,
India
anurupbckv@gmail.com, parvez.iasri.13@gmail.com, jitbasak9@gmail.com,
ankita.manoj1993@gmail.com

Supersaturated designs are very useful for screening experiments with many factors using only a few runs or design points. The widely accepted criteria for optimality of two level supersaturated design is the $E(s^2)$ measure where the design matrix X_d has the restriction that either each column sum will be zero for balanced supersaturated designs or each column sum will be ± 1 for nearly balanced designs (Gupta, 2010). The present article comprises two different parts. In the first part, some new methods of construction of balanced and nearly balanced supersaturated designs have been presented. The methods yield some new balanced and nearly balanced optimum supersaturated designs which are not yet reported in the available literature. Many available supersaturated designs can also be constructed from these methods; in the sense these methods are more general. The developed designs are examined by sharper lower bounds of $E(s^2)$ measures (Suen & Das, 2010). The design points of some designs are given in Appendix I. Second part developed two level balanced supersaturated designs involving maximum possible number of factors for any particular number of runs, i.e. designs with max. m for n , where m be the number of factors and n be the number of runs. The developed designs for $n=6, 8$ and 10 are given in Appendix II. Any two level supersaturated design must be a sub design of the developed designs with maximum factors for any n .

**PP196: Development of regression model to predict yield responses to climate change in
castor crop
(Abstract Id: A12-13-028)**

^aK Alivelu, ^aC Sarada, ^bP Lakshamma and ^cA R Surendra
^aSocial Sciences, ICAR-IIOR, Hyderabad, India
^bCrop production, ICAR-IIOR, Hyderabad, India
^cAgricultural Statistics, IGKV Raipur, India

Reliable and timely yield forecasts are enable farmers for timely decision making in crop management. Oilseeds cultivation is undertaken across the country in about 27 million hectares mainly on marginal lands, out of which 72% is under rainfed farming. Their productivity completely depend up on weather factors. Mann Kendall nonparametric test was used for identification of trend. Sen's slope estimator was used to estimate magnitude. Annual as well as seasonal rainfall showed significant decreasing trend and Maximum and minimum temperatures showed significant increasing trend of 0.16, 0.11 and 0.14 °C per decade since 1981. Max warming trend is seen during post monsoon season. Time series of castor yield in India showed increasing trend which is an indication of improving yield over time. To determine the relationship between yield and climatic parameters, Correlation analysis was carried out to know the relation between weather variables Rainfall Maximum temperature and minimum temperature and yield indicated that positive correlation exist between yield and weather variables. Gujarat covers 60 percent of castor area and yield increased from 1.988 ton to 2.072 ton per hectare. Multiple regression model was developed to predict yield based on Rainfall, maximum and minimum temperatures with R^2 0.79. Contingency table was used to verify the model. A 10 year data set was used to train the model. It was observed that 70 % model forecasts were correct. An average post agreement rate of 77.3 % was observed indicating that the majority of the forecasts were true.

**PP197: Identification of factors affecting in rice production of Manipur
(Abstract Id: A12-13-009)**

^aSoibam Loidang Devi and ^bChangamayum Girija Devi

^aDepartment of Statistics, D M College of Science, Dhanamanjuri University, Imphal,
India

^bDepartment Of Statistics, Manipur University, Imphal, India
loidang023@gmail.com and gijachang01@gmail.com

Manipur, an Indian Easternmost State internationally bordering with Myanmar, has rice production as major livelihood and other natural resources are taking very low contribution to NSDP. Henceforth, the factors contributing in enhancement of the agriculture production have to be identified so as to gear up the sustainable development in that state. In this paper the objective is to identify the factors of rice crop associated with various socio-economic and agro-climatic conditions of Manipur. Based on a primary data, the variations in agricultural productions particularly that of rice has been examined by using principal component analysis to identify the high contributing, factors on the rice production. Out of fifteen principal components, only six principal components are selected to be total variance extracted from the empirical data being 1 and greater. The total variance extracted by the first principal component is 3.01(20.1%) and other components' variances are varying from 6.8% to 11.4%. Findings show that the analysis carried out in the existing data is quite satisfactory.

**PP198: Inference for the unit-Gompertz model based on record values and inter-record times with an application
(Abstract Id: A12-13-020)**

Devendra Kumar

Statistics, Central University of Haryana, Mahendergarh, India
devendrastats@gmail.com

Mazucheli et al. (2019) introduced a new transformed model called the unit-Gompertz (UG) distribution which exhibits right-skewed (uni-modal) and reversed-J shaped density and its hazard rate function can be constant, increasing, decreasing, upside-down bathtub and bathtub shaped. They worked on the estimation of the model parameters based on complete data sets. In this paper, by using lower record values and inter-record times, we develop inference procedures for the estimation of the parameters and prediction of future record values for the UG distribution. First, we derive the exact explicit expressions for the single and product moments of lower record values, and then use these results to compute the means, variances and covariances between two lower record values. Next, we obtain the maximum likelihood estimators and associated asymptotic confidence intervals. Further, we obtain the Bayes estimators under the assumption that the model parameters follow a joint bivariate density function. The Bayesian estimation is studied with respect to both symmetric (squared error) and asymmetric (linear-exponential) loss functions with the help of Tierney-Kadane's method and Metropolis-Hasting algorithm. Finally, we compute Bayesian point predictors for the future record values. To illustrate the findings, one real data set is analyzed, and Monte Carlo simulations are performed to compare the performances of the proposed methods of estimation and prediction.

**PP199: Measurement of poverty in India-1
(Abstract Id: A12-13-010)**

Mukesh
Government of India, NSSO, New Delhi, India
mukesh.iss.goi@gmail.com

National Sample Survey Office (NSSO) of Government of India has conducted household's consumer expenditure survey during 2017-18, covering entire geographical area of India. The survey had a scientific sampling plan and detailed data was collected on almost all possible consumption items which are there in the normal consumption basket of the Indian households. The data generated by the consumer expenditure surveys has been used by Government of India to design various developmental policies. The most important use of data of consumer expenditure survey is for measuring of poverty in India. Measurement of poverty has two components. First is fixing of poverty line and second is counting the number of persons with per capita monthly expenditure below the poverty line. The number of persons below the poverty line as the percentage of total persons is called Head Count Ratio (HCR). This paper attempts to calculate the poverty line in rural and urban areas at all India level and also at the level of States / UTs. Generally, in India per capita monthly expenditure of household members is calculated by dividing total monthly expenditure of household with household size. However, in this paper per capita monthly expenditure has been calculated by dividing total monthly expenditure of households with consumption units in the households. This is because with introduction of an additional household member, the same incremental increase in per capita monetary value may not be required by the household to maintain its standard of living. The number of consumption units in the households is calculated as the combination of weightings allocated to each member with the formula: $= 1 + (a-1) \times 0.7 + (b-1) \times 0.5$, Where a is the number of adults and b is the numbers of minors. Now once the consumption units has been calculated for each household then each member of household is allocated per capita monthly expenditure based on the weight of associated consumption units. Further, all the persons are arranged in the ascending order of their allocated per capita monthly expenditure and then median of the distribution of allocated per capita monthly expenditure is calculated. The poverty line is fixed as the percentage of this median. In this paper, five poverty lines have been worked out separately for rural and urban India and for different States/UTs within the geographical location. These poverty lines are at 20%, 30%, 40%, 50% and 60% of the median of the distribution of allocated per capita monthly expenditure. This line divides people into poor and not poor. After getting the poverty line, incidence, distribution and intensity of poverty have been estimated as the measures of poverty for India. The incidence of poverty has been measured as the poverty rate that is percentage of poor people within the total population. Distribution of poor people has been studied according to age, gender, social groups, religions and level of educations. Poverty gap, which is the distance of individual poor from the poverty threshold, have been calculated to study intensity of poverty in India.

PP200: New construction with application of optimal covariate designs (ocds) in split plot design set up
(Abstract Id: A12-13-021)

^aDikeshwar Nishad, ^bAnurup Majumder, ^cManoj Kumar, ^dHiranmoy Das, ^bParvez Mallik
and ^bAnkita Dutta

^aAgricultural Statistics, IGKV, Raipur, Raipur (C.G.), India

^bAgricultural Statistics, BCKV, Mohanpur, Mohanpur, Nadia, (W.B.), India

^cAgricultural Statistics, CIAE, Bhopal, Bhopal (M.P.), India

^dAgriculture Statistics, IISS, Bhopal, Bhopal (M.P.), India

dikeshwarnishad89@gmail.com, anurupbckv@gmail.com, manoj_iasri@yahoo.com,

hiranmoydas.stat@gmail.com, parvez.iasri.13@gmail.com,

ankita.manoj1993@gmail.com

Lopes Troya (1982a, 1982b) initiated the concept of Optimum Covariate Designs (OCDs) in CRD set up. Das et. al. (2003) reinvestigated the topic and constructed Optimum Covariate Designs (OCDs) in

RBD and BIBD set up by using Mutually Orthogonal Latin Squares (MOLS) and Hadamard matrices. Thereafter many published articles on OCDs for different design set ups. Das et. al. (2015) also made an in-depth study on ‘Optimal Covariate Designs’ covering developments so far, in the topic of optimum covariates for different design set ups. The present article focused on construction and application of optimal/most efficient covariates in split plot design set up with p main plot factors and q sub plot factors in r randomized blocks when the Hadamard matrix of order p or q or r does not exist. The different sets of optimal covariates (one, two and three) were applied on real data of a field experiment conducted in 3x4 split plot design with two randomized blocks and the comparisons have been made among the ANOVA, ANCOVA and OCDs based on the relative efficiencies (R.E.%).

**PP201: New sets of d-optimal experimental designs with one-way and two-way classified intercepts for covariate models
(Abstract Id: A10-11-002)**

^aHiranmoy Das, ^bAnurup Majumder, ^bDikeshwar Nishad, ^cManoj Kumar, ^aPradip Dey and ^aA.K. Patra

^aICAR-Indian Institute of Soil Science, Bhopal, India

^bDepartment of Agricultural Statistics, Bidhan Chandra Krishi Viswavidyalaya, Nadia, India

^cAgricultural Mechanization Division, ICAR-Central Institute of Agricultural Engineering, Bhopal, India

hiranmoydas.stat@gmail.com, anurup.bckv@gmail.com,
dikeshwarnishad89@gmail.com, manoj_iasri@yahoo.com,
pradipdey@yahoo.com and patraak@gmail.com

The study of optimal design for covariate models in CRD set-up was initiated by Troya (1982a, 1982b). Das et. al. (2003) followed up the study and extended for RBD set-up. Recently Das et. al. (2015) published a book on ‘Optimal Covariate Designs’. In the study, one new set of D-optimal covariate designs in Experimental Design with One-way Classified Intercept Model (CRD) set-up and two new sets of D-optimal covariate designs in Experimental Design with Two-way Classified Intercept Model (RBD) set-up have been developed. The methods of constructions of D-optimal covariate designs are developed with the help of a new matrix viz., Special Array (as defined). The existence of H_v and H_{b-1} can develop $c = (v - 1)$ number of D-optimal covariates in CRD and RBD set-ups with the treatment number v for any odd number of replications or blocks, b . If H_v and H_{b-1} exists, then $c = (v - 1)$ D-optimal covariates will exist in a RBD set up with v number of treatments for b odd number of blocks provided $r (> 1)$ is a odd number and H_{r-1} exist, where r is the number of rows and columns in the Special Array with all elements zero. The developed D-optimal covariate designs are not available in the existing literature.

**PP202: The Impact of technology transfer on Zimbabwe’s agriculture development:
GTAP model analysis
(Abstract Id: A12-13-015)**

Rutendo Happy Jonga, Huang Delin, Benito Giovanni Reeberg and Christopher Belford
Agricultural Economics and Development, Graduate School of Chinese Academy of
Agricultural Sciences, Beijing, China
rutendojonga@yahoo.com, huangdelin@caas.cn, benitoreeberg@gmail.com,
cbelford@utg.edu.gm

Zimbabwe like any other developing country needs technology to drive its economic growth. Many

organizations and its international partners have been assisting the country through various forms so as to boost its economy. Having assessed Zimbabwe's exports since the adoption of the multi-currency regime in 2009, the country's exports show fluctuations with small magnitudes in increment as if to say the level of technology and assistance that has been offered to the country does not have an impact on the country's sectoral outputs. However, some of the country's international partners are not giving up on the nation but are establishing a cooperation with it to transfer technology through various mechanisms with the aim of modernizing the agricultural sector. This is because the agricultural sector remains as the backbone of the country's economy. The study therefore having acknowledged the importance of technology transfer in economic growth and competitiveness, conducted three different scenarios. Using a Global Trade Analysis Project (GTAP) Static model of a 2011 GTAP9A database, different policy levels of technology (5%, 8% and 10%) were proposed to be increased to the country's agricultural sector technology to assess the impact of technology transfer on agricultural development. The simulation indicated that, at all proposed levels of increment the country's GDP, welfare, value added in the agricultural sectors and the quantity produced in all the industries would increase. The CPI reflected a more moderate inflation at 5% and 8% increase more than at 10%. However, at all levels the volume of merchandise exports indicated a decrease. The study then recommended that Zimbabwe needs to upgrade its domestic value chains and position itself in the global value chain in order to increase its competitiveness in the global market.

**PP203: To be or not to be a win-win situation, as Zimbabwe diversifies its agricultural exports in the Chinese market
(Abstract Id: A12-13-014)**

Rutendo Happy Jonga, Huang Delin, Benito Giovanni Reeberg and Christopher Belford
Agricultural Economics and Development, Graduate School of Chinese Academy of
Agricultural Sciences, Beijing, China
rutendojonga@yahoo.com, huangdelin@caas.cn, benitoreeberg@gmail.com and
cbelford@utg.edu.gm

Using the Global Trade Analysis Project (GTAP) static model (2011 Input-output table), this paper analyzes the effect of diversifying Zimbabwe's agricultural exports in the Chinese market both to the Zimbabwean and the Chinese economy as Zimbabwe aims to expand its agricultural exports. This was based on 2018 Zimbabwe's cooperation with China, under the auspices of the Belt and Road Initiative and the Forum for China-Africa Cooperation Action Plan (2019-2021). The study was based on the assumption that China would establish a bilateral free trade agreement with Zimbabwe hence, a tariff elimination was imposed on all Zimbabwe's agricultural commodities that are currently being exported to China, based on the GTAP9A database. The study indicated that the quantity GDP of Zimbabwe would be positively impacted more than most of other aggregated regions, and that of China would increase but not change significantly. The output of all the agricultural and non-agricultural sectors showed a negative impact on Zimbabwe and a positive impact on China. Although slightly higher than the other regions, Zimbabwe's CPI indicated a moderate inflation and it was the same for all the other regions. The welfare effect indicated that Zimbabwe would improve in its welfare than China. The study concluded that the policy simulation would be a win-win situation between the two countries. We propose some policy recommendations to improve and ensure a win-win situation between Zimbabwe and China Cooperation. Such as the need for improved technology in Zimbabwe's agricultural sector to increase productivity and also, the need for the region to engage in research and development so as to improve the sector's domestic value chains especially for commodities that are being exported as primary products, with the goal of improving the country's competitiveness in the global markets.

**PP204: Weather based modelling and forecasting of rice gall midge populations:
Application of machine learning techniques
(Abstract Id: A12-13-018)**

^aSridhar Y, ^bSantosha Rathod, ^aMalathi S, ^aKarthikeyan K, ^aChaudhari B N and ^aKatti G

^aAgril. Entomology, ICAR-Indian Institute of Rice Research, Hyderabad, India

^bAgril. Statistics, ICAR-Indian Institute of Rice Research, Hyderabad, India

yerramsridhar303@gmail.com, santoshagriculture@gmail.com, seetalam@yahoo.com,
entokarhi_65@hotmail.com, bncent@rediffmail.com, Gururaj.Katti@icar.gov.in

Asian rice gall midge (*Orseolia oryzae* Wood-Mason) is a major insect pest in rice cultivation. In India it occurs in Eastern, Central and Southern rice cultivation zones. Gall midge is endemic to Warangal, Maruteru, Pattambi, Sakoli, Jagdalpur, and Chiplima. Gall midge young ones feed on the shoot meristem during tillering stage resulting into formation of 'silver shoots,' which fail to bear panicles. Under favorable conditions it is reported to cause 20-70% yield losses. Besides inherent biotic potential, to a large extent, abiotic factors like temperature, rainfall, relative humidity, sunshine hours, etc. determine the abundance of insect pests in a crop ecosystem. It is desirable to develop an efficient forewarning system based on a robust model for designing effective location specific pest management strategies. In this study, gall midge populations were recorded daily, using light trap (Chinsurah/Robinson type). Corresponding weather data on temperature, rainfall, relative humidity, sunshine hours, etc. were also collected. Weekly cumulative catches of gall midge and weekly averages of weather parameters were subjected to time series generalized linear model (ts-GLM) and machine learning techniques to predict the future populations. Empirical results revealed that machine learning technique outperformed classical GLM model in prediction of gall midge populations both in training and validation of data.

**PP205: ECA data collection strategy for compiling EE-SUT of forest accounts
(Abstract Id: A2-2-046)**

Ali Yedan

Africa Centre for Statistics, United Nations Economic Commission for Africa (UNECA),
Addis Ababa, Ethiopia
yedan@un.org

The forest plays an important role in the sustainable development of a country. Forest products are first provided by nature, used by industries to produce outputs. Countries also import and export wood products. The knowledge of forest and forest products data and statistics becomes paramount for all countries. It enables countries to identify their development priorities, baselines, targets and goals; directly support countries in measuring, monitoring, and evaluating the Sustainable Development Goals (SDGs) and is instrumental in evidence-based planning, policy formulation and decision making. In this regard, the United Nations Economic Commission for Africa (UNECA) has launched a capacity building programme on the compilation and application of EE-SUTs. EE-SUTs refers to the "environmentally-extended Supply and Use Tables." an EE-SUT starts with the national accounts based SUTs by adding a few columns and rows to take into account environmental issues to reach to the SEEA based physical Supply and Use Tables (PSUT). In the presentation, we describe the procedures and steps of this compilation which is in three phases: Phase I is the e-training with participants from almost all African countries. Phase II is the face-to-face seminar and Phase III is this capacity building programme national workshops and on-site technical assistance on the System of Environmental-Economic Accounting (SEEA). Phase III will support country in defining and laying out the overall structure of the EE-SUTs on forestry (including classifications of industries and products). We briefly show how we compiled the EA-SUTs by showing sources of data and methods

for estimating missing data from all existing sources. The compilation is in accordance with the System of National Accounts (SNA 2008) based on the System of Environmental-Economic Accounting Central Framework (SEEA-CF), so that the resulting figures can better support analysis on current macroeconomic conditions and facilitate economic policy-making. United Nations Economic Commission for Africa (UNECA), in collaboration with FAO organize the follow-up Phase III of this capacity building programme national workshops and on-site technical assistance on the System of Environmental-Economic Accounting (SEEA) and the SEEA for Agriculture Forestry and Fisheries (SEEA AFF) in three countries Senegal, Morocco and Cameroon.

**PP206: Forest statistics from local to global scales: The SEEA AFF forest accounts application in Senegal, Morocco, Cameroon
(Abstract Id: A2-2-047)**

^aSilvia Cerilli, ^aFrancesco Tubiello and ^bXiaoning Greg

^aStatistics Division, Food and Agriculture Organization of the United Nations (FAO),
Rome, Italy

^bAfrican Centre for Statistics, United Nations Economic Commission for Africa
(UNECA), Addis Ababa, Ethiopia

Silvia.Cerilli@fao.org, Francesco.Tubiello@fao.org, xiaoning.gong@un.org

Highly quality economic and environmental statistics are important inputs into evidence-based policy formulation and decision-making. Policies of conservation of forestry potential and ecological balances, or of satisfaction of national demand of timber and non-timber products need accurate information, relying on a robust statistical framework, as the SEEA CF, endorsed in 2012 by UNSC as the first UN environmental – economic statistical framework. The System for Environmental-Economic Accounting for Agriculture Forestry and Fisheries (SEEA AFF) applies the environmental economic structures and principles described in the System of National Accounts (SNA) and in the System of Environmental Economic Accounting - Central Framework (SEEA-CF) to the activities of Agriculture, Forestry and Fisheries. It has been endorsed by the UNCEEA in March 2016 as “Internationally Agreed Methodological Document in support of the SEEA CF”. The SEEA AFF includes accounting structure for Land Use, Land Cover, Forest and other wooded Land national and international data (FAOSTAT). In particular, it includes Environmentally Extended Supply and Use Table on Forestry Products, whose application and implementation in Senegal, Morocco and Cameroon is the main scope of this paper. The SEEA AFF Physical flow account for wood forestry products records the flows in physical terms of wood products (timber) deriving from economic activities (ISIC A 021) and logging activities (ISIC A 022). The SEEA AFF expands its analysis to forestry products other than wood such as for instance resins and gums, mushrooms, wild honey, edible insects, which are derived from economic activities classified under ISIC A 023 “Gathering of non-wood forest products” (NWFP). This accounting table has been selected by the Cameroon National Statistical Office (INS), the Morocco Haut-Commissaire au Plan (HCP) and from the Senegal Agence Nationale de La statistique et de la Démographie (ANSD), the in the framework of the UNECA Phase III of the capacity building on EE-SUTs for national implementation. The objective of this phase of the UNECA programme is to provide technical support for those pilot countries to compile one account of their selection in the coming six to nine months. This is after completing the first two phases (i.e. Phase I in “e-Training” and Phase II in “face-to-face regional seminar”). In fact, the scope and structure of this accounting table was first introduced in Pretoria, South Africa, in July 2018 to participants of the Training on Compilation and Application of Environmental Extended Supply and Use Tables in the framework of UNECA Phase II of the EE-SUT programme. Later, under the request of ANSD, INS and HCP in the framework of UNECA Phase III on EE-SUT, it was further analyzed and ad hoc changes were introduced to better capture the more important timber and non-timber products for Cameroon, Morocco, and Senegal. This paper explores these three countries implementation results and challenges in compiling the SEEA AFF PSUT on Forestry products. The paper describes main findings in terms of contribution of the forestry

sector to Senegal, Morocco and Cameroon GDP and explores methods of estimates for non-wood forest products.

**PP207: An analysis of distribution of agriculture land and food insufficiency in Nepal
(Abstract Id: A5-7-023)**

Kishor K.C.

Central Bureau of Statistics, Central Bureau of Statistics, Kathmandu, Nepal

kckishornp@gmail.com

Agriculture is the backbone of the Nepalese economy. It still occupies about 27% of GDP and absorbs about 65% of labour force of the country. About 70% households are engaged in agriculture activities. However most of the households (55%) occupies small area of agriculture land (less than 0.5 hectare) and practices subsistence farming (64%). According to the last agriculture census 2012, six out of 10 holdings reported that their agricultural produce was insufficient to feed the household for the whole year. The distribution of land is highly unequal with concentration index 0.49 and the food insufficiency is prone to certain areas and sub-groups of the agriculture households. Thus, the development of agriculture sector is key to the economic development of country. The national agriculture census 2012 of Nepal provides information on agriculture holdings by size, type of ownership and tenure, sex and ethnicity of the holder and by geographical distribution. The food sufficiency among agriculture households are based on responses of holdings to the questions asked relative to the sufficiency of agricultural produce for the consumption of the households. The agriculture census could be a good source of data for the SDG indicators 2.1.2 and 5.a.1, if some modification or improvement is done in questionnaire of upcoming agriculture census of Nepal in 2022. The SDG indicator 5.a.1 which measures the extent of women's ownership of agricultural land the SDG indicator 2.1.2 provides the measure of severity of food insecurity in the population (among agriculture households), based on the subjective judgment of the respondents and measured by Food Insecurity Experience Scale. In this context, the paper provides a comprehensive information on the situation of food sufficiency by agriculture land distribution, geographical area, caste and ethnicity and by gender of agriculture holders. It uses microdata of the last agriculture census of Nepal and analyzes the relation between holding size and food insufficiency situation in Nepal. The SDG metadata of the indicators 2.1.2 and 5.a.1, and the FAO guidelines for the World Programme for the Census of Agriculture 2020 (WCA 2020) will be reviewed for developing appropriate questionnaire in upcoming agriculture census 2022 for the estimation of the two indicators. The findings from this study will be helpful to improve the questionnaire of the next agriculture census and Agriculture Integrated Survey (AGRIS) in capturing necessary information for food insecurity and women's ownership of agriculture land which ultimately helps to formulate appropriate policies and monitor progress regarding to distribution of agriculture land and food security situation of Nepal.

**PP208: The role of surveys in the production of official statistics—now and in the future
(Abstract Id: A2-2-044)**

Tapas Kumar Sanyal and Salil Kumar Mukhopadhyay

National Statistical Office, Survey Design and Research Division, Kolkata, India

tk_sanyal@yahoo.co.in, salil.kumar59@gov.in

The Role of Surveys in the Production of Official Statistics—Now and in the Future - T. K. Sanyal and Salil Kumar Mukhopadhyay Abstract Surveys to produce official statistics generally focus on one major area of study and the activities of survey such as data collection, processing and release of results inherently create some time lag on completion of survey and actual availability of survey results. This poses considerable hindrance on the administrators, policy makers, financial markets and entrepreneurs for policy intervention and taking corrective measures. The methodology and the

technology for survey operations are witnessing changes to improve reliability, accuracy and timeliness. The switch-over from Pen-and- Paper Personal Interview (PAPI) to Computer Assisted Personal Interviewing (CAPI), Computer-Assisted Telephone Interviewing (CATI) or Computer-Assisted Web Interviewing (CAWI) to collect data with additional advantages of data validation is reinforcing the importance of survey data. Diversification of survey products, use of model based estimates as well as use of big data and web scrapping along with survey data for nowcasting and feasibility of data integration are creating potentiality to view survey as an important tool for administrators, policy makers and researchers. The survey methodologies are in the constant process of evolution to improve quality, timeliness, reduce costs and burden on respondents.

PP209: Agriculture census 2021 in Nepal to achieve the sustainable development goals (SDGs)

(Abstract Id: A6-8-014)

Shiv Narayan Mahato
Central Bureau of Statistics, Statistics Office, Gaighat, Nepal
mahatoshivnarayan@gmail.com

Agriculture census 2011 in Nepal to Achieve the Sustainable Development Goals (SDGs) Agriculture contributes to about one third of Nepal's Gross Domestic Product (GDP) and employs about two-thirds of the population directly or indirectly. Agriculture being highly vulnerable to climate change, experiences far-reaching impacts with implications on Sustainable Development Goal (SDG) . Since these impacts directly affect the livelihoods of a large number of people depending upon agriculture, it is important to integrate all plans of agricultural at all levels of government— local, provincial and federal. The Government of Nepal (GoN) was focusing on multi-sector approach after the strong recommendation of Nutritional Assessment and Gap Analysis (NAGA) drawn in 2010. Nepal is currently implementing agriculture development strategy (ADS) a vision for next 20 year since 2015 for overall development of agriculture sector. One of the objectives of ADS is to improve the food and nutrition security status of the people; particularly the most disadvantaged and marginalized groups. Nepal has also made many international commitments such as Undertaking Zero Hunger Challenge 2016-2025, Sustainable Development Goal (2016-2030) II including Agricultural Development Strategy (2015- 2035), the Food and Nutrition Security Plan of Action (2013-2022), Multi-sectorial Nutrition Plan (2018-2022), to achieve food and nutrition security within a period. Many projects and programs are funder implementation through different governmental and nongovernmental sectors to achieve food and nutrition security in Nepal. Hence it is imperative to know who is doing what in food and nutrition security to achieve the national goal and streamline the whole system into single pathway. It also helps to avoid duplication of the program and builds synergy in achieving the goal. Poverty is overwhelmingly rural and most of the country's poor are small-scale farmers with low nutritional status. Increase in rural incomes will continue to drive poverty reduction and improved nutrition over the medium- term. In Nepal, Agricultural exhibits persistent vulnerability to shocks, including climate change evidenced by the 7.8 magnitude earthquake of April 2015 which has set back the country's development. The rural areas were particularly hard hit, with crop losses and loss of post-harvest storage infrastructure. This event have contributed to a slowdown in agricultural growth to less than 1% in FY 2015 and 1.3 % in FY 2016, compared to annual growth rates for agriculture GDP over the previous decade of about 3 % per annul. But due the climate change and and monsoon rain in raining season the production of paddy is significant high and so the agriculture growth is 5.02 % in FY 2018 . After the Constitution of Nepal 2015 , Nepal become federal country taking seven provinces . After the Agriculture Census which will conduct in 2021 will provide detail information about those provinces. It will help to plans of agricultural at all levels of government—local, provincial and federal. The next Agriculture Census will help to achieve the goal of Sustainable Development . The sampling frame for agriculture census 2021 would involve all local bodies so that its results will also publish at local levels.

PP210: A review of fisheries data collection system in Malawi
(Abstract Id: A2-2-012)

Mexford Mulumpwa

Department of Fisheries, Monkey Bay Fisheries Research Station, Mangochi, Malawi
mulumpwa.mexford@gmail.com

Malawi uses two data collection systems namely Catch Assessment Survey (CAS) and Malawi Traditional Fisheries (MTF). CAS data collection system involves data collection from four randomly selected sample fish landings sites in a month. These sites are identified during previous annual frame survey in each stratum. Data collected during sampling period includes: catch in weight by type of fish, type of canoes/boats, number of fishermen involved in sampled canoe and type, size and number of gears. However, MTF was proposed to replace CAS because it does not take into account gear distribution and gear operation methods. MTF is gear-based data collection system designed for storage, processing and reporting statistical information from artisanal fisheries. Unlike CAS, this system involves collection of data from a few selected landing sites. The selection of these landing sites like CAS is based on results of previous annual frame survey. The few data collected is used to estimate total fish landings by applying raising factors. MTF has two main sampling activities namely sampling for catch and effort by species and sampling for gear activities. MTF designed and introduced by FAO replaced CAS in Mangochi District in late 1990s as a pilot stage so as to be rolled out to all other fishing districts in Malawi. However, up to now due to lack of resources MTF is yet to be introduced in other fishing districts and still operating on Windows SP. MTF was design to minimize errors that CAS make. A study was done to appraise MTF data collection system as it has been in place for over 20 years in the face of significant fishery characteristics changes over time. The study employed data from 1999-2018 for analysis. As much as MFT is better, it is not benefiting Malawi as expected as it is still localized to a single district due to high cost of implementation than CAS. As such there is a need to develop a less costly to implement data collection system that can replace CAS as much as MTF. CAS fisheries data collection system in Malawi is regarded as weak and unreliable. However, through this study it has been observed that there is minimal supervision of both MTF and CAS as such this is compromising quality of data. The source of error that arise from a loosely structured data collection system with limited supervision needs to be significantly minimized to make it more effective and efficient. There is a need to properly enter and store data in a regularly maintained database for easy retrieving and avoiding data lose. The catch returns system from commercial fishers needs to be revisited or seriously enforced otherwise large-scale data is way underestimated. There is a need as well to prioritize on data generation for proper allocation (licencing) of large-scale fishers based on biomass stand and not mare catch rates of a seldom supervised data collection system.

PP211: ICASEES/CAR/2019
(Abstract Id: A1-1-021)

Yezia Bertin Romaric

Direction of the Methods, Standards, Studies and Research , Central African Institute of
the Statistics and the Economic and Social Surveys, Bangui, Central African Republic
bertin_yezia@yahoo.fr

Head of Service of the Studies and Research by interim at the Central African Institute of the Statistics and the Economic and Social Surveys. I have the role of : to identify and index topics of studies and research on the economic and social subjects of topicality ; to make studies deepened starting from the data of investigations in collaboration with a multi-field team ; to organize the

validation of the projects, the procedures and the results of the studies and research, in partnership with the Universities and the Centers of Formation ; to support the other structures in the design of the investigations ; to contribute to the definition of the principal national and regional statistical indicators and to install the instruments of the collection and follow-up ; to follow the evolution of the principal indicators of the living conditions of the households and poverty ; to develop, feed, put on line and to manage the data bases of the CAR. The Central African Republic is a country post conflict and that made at least 10 years that it did not carry out a General Census of the Population and a Habitat (RGPH) and investigations of great scale. We prepare to carry out the RGPH, the Agricultural Census (noncarried out since at least 20 years) and great investigations in 2020. The respect of calendar and the limiting date to deliver information for its use is of capital importance in the management centered on the results. To face this challenge, the recourse to the technological development proves to be necessary. Data-gathering while resorting to Smartphones, shelves, or computer is a solution already tested for the promptitude and the data acquisition of quality. The completion of the process of census and/or the investigations means collect, the treatment and analyzes data, and the diffusion and the use of the products and results for programming and decision-making based on the results. One of the tasks more significant in an operation of census is the analysis of the data of the census and has stressed that for the majority of the countries of Africa, the volume of information collected is only partially analyzed and diffused and often in a discontinuous way, thus translating under evaluation of the census and an underutilization of the results. It stressed that there is one need for a thorough analysis for the data of the census to the place only of figures relating to the size or manpower of population. Following the sociopolitic crises that the CAR knew, the need to have data is particularly acute and the country tests many the difficulties of building and of perennializing an effective national statistical system. To this end, the country, through these frameworks working in the field of statistics needs to obtain the capacities necessary to lead statistical surveys and censuses, to compile data coming from various sources and to place at the disposal of the statistical indicators and other data for the decision- making.

PP212: Reducing Implementation Cost in Agricultural Surveys: Solutions and Country Cases
(Abstract Id: A2-2-007)

Dramane Bako and Flavio Bolliger
FAO Statistics Division, Rome, Italy
Dramane.Bako@fao.org, Flavio.Bolliger@fao.org

One of the main challenges of the production of agricultural statistics in developing countries is the high implementation cost of agricultural surveys. Important factors that affect survey cost are sample size and interview time. This paper will discuss solutions related to these two factors in order to make agricultural data collection sustainable for developing countries. Discussion points cover issues related to scope of the survey, optimal sample size and allocation, questionnaire administration approach and field operation organisation using emerging advanced statistical techniques and examples from countries experiences.

PP213: A study of the changes in forestry census survey methods and difficulties facing forest owner surveys in Japan
(Abstract Id: A2-4-013)

Koji Matsushita
Graduate School of Agriculture, Kyoto University, Kyoto, Japan
matsu@kais.kyoto-u.ac.jp

In Japan, the Forestry Census (hereinafter, Census) began as part of the 1960 World Census of Agriculture and Forestry, which was performed every 10 years until 2000. Before the Census, only basic data (e.g., number of forest owners, holding area, etc.) were (irregularly) collected by the Japanese Forestry Agency through prefecture-level forestry departments. Today, nearly 60 years after the first Census, the circumstances surrounding the gathering of forestry data have changed greatly. For instance, the number of Ministry of Agriculture, Forestry and Fisheries staff assigned to the generation of statistics has decreased, and surveys on forest resources and forestry have been greatly reduced in scope. For example, in the 2000 Census, the definition of forest owners changed from a minimum holding size of 0.1 ha to 1 ha. Subsequently, in the 2005 Census, the agricultural and forestry surveys were merged to create the Survey of Agriculture and Forestry Management Entities, conducted according to a 5-year interval. At that time, a new concept, forest management entities, was introduced, where such entities are defined as meeting one of the following criteria: (1) the execution of forest management practices during the previous 5 years (holding size ≥ 3 ha); (2) the creation of a forest management plan that includes the survey year (holding size ≥ 3 ha); (3) timber production by a trust, or purchasing of standing timber (annual production ≥ 200 m³); and (4) forestry activities other than timber production, such as forestation. Thus, in the most recent 2015 Census, there were approximately 87,000 forestry management entities, which included 78,000 family-owned entities. By contrast, in the 1990 Census and 2000 Census, there were approximately 2.5 and 1 million forest owners with a holding size ≥ 0.1 and ≥ 1 ha, respectively. The main cause of this decrease in forest owners was the introduction of the four aforementioned criteria used to define forestry management entities. However, the decrease has also resulted from the decline of the domestic forest products market, driven by the decrease in size of the total Japanese population, as well as the decrease in need for plantation forest management (e.g., weeding and thinning) seen over the past 50 years. Forestry management, especially for older plantation forests, does not require care on an annual basis, in contrast to agricultural systems. As an additional challenge for surveys, it is becoming increasingly difficult to actually locate forest owners. In 1960, most forest owners were farmers; however, the percentage of farmer forest owners is decreasing, whereas the percentages of other types of forest owners (e.g., non-resident, non-farmer, and aging owners) is increasing. Given such changes, it is difficult for the agriculture and forestry departments of central and local governments to locate non-resident forest owners who live mainly in urban areas, non-farmer forest owners, and aging forest owners who no longer live on their property. In addition, the number of forests with unknown owners is increasing. Considering these changes, and the difficulties associated with surveying forest management entities and forest owners, new methodologies for collecting forestry data and identifying forest owners must be investigated.

PP214: Data collection of rural social development under mass migration: the case of China
(Abstract Id: A2-4-028)

Suyu Liu
Linacre College, Oxford University, Oxford, United Kingdom
suyu.liu@linacre.ac.uk

Data collection of rural social development has been demonstrated to be with significant challenges, especially in countries which have mass rural-urban migration. This is because, due to the mass rural-urban migration and rapid urbanisation, the high mobility of rural-urban migrants are hard to be identified, and their core socioeconomic circumstances change frequently and sharply. In addition, they are often beyond the statistical measurement of statistical authorities due to practical difficulties. Using the case of China, which experiences mass rural-urban migration and rapid urbanisation, this research provides a few new measurements and indicators to monitor some key socioeconomic circumstances of the rural-urban migrants. Firstly, this research suggests to use the rural high-school student registration number minuses the number of junior-middle school completers to proxy the

number of young (under 18) rural-urban migrant workers. This is because in China it is legally required to complete junior- middle school and the law enforcement is strict. Therefore, those who do not pursue high-school studies are very likely to migrate and work in urban regions. Secondly, this research suggests to use the amount of remittance as a proxy of rural-urban migrant workers' actual incomes of their work. This is because a large proportion of incomes are paid in cash or via informal channels, which are difficult to be observed by official statistics. However, all remittances in China must be officially registered (usually with the banking system). This is a reliable proxy of rural-urban migrant workers' real income, if a reasonable estimate of their consumption is given. This is also based on the popularly-believed tradition that migrant workers usually remitted the vast majority of their savings of incomes to their families in rural areas. Given suitable understanding of the differences in country context, these two indicators can also be applied into other countries. This is especially the situation for developing countries with mass rural-urban migration and rapid urbanisation, in which rural-urban migrant workers demonstrate similar income patterns and socioeconomic circumstances.

PP215: Reducing the risk of errors in the achievements of agricultural censuses in Sub-Saharan Africa: In search of the determining factors
(Abstract Id: A2-2-026)

^aNtouda Julien, ^bKana Christophe and ^cNjabe Elvis

^aGeneral Census of Agriculture and Livestock, Ministry of Agriculture and Rural Development, Yaoundé, Cameroon

^bQuality, Cameroon National Institute of Statistics, Yaoundé, Cameroon

^cConsultant, Nutrition International, Ottawa, Canada

julienntouda@yahoo.fr, christkana@yahoo.com, njabelvis@gmail.com

Developing countries and their technical and financial partners recognize that quality statistics are a key tool for development-oriented policy and planning. They also recognize that it is an indispensable element in policy formulation and implementation, monitoring and evaluation of the results and impacts of development initiatives such as the Sustainable Development Goals (SDGs), poverty reduction strategies and sector strategies. Indeed, they are useful for identifying problems and needs to be met, as well as for informing the evaluation indicators of policies and programs implemented. In other words, good quality statistics are an integral part of a development-friendly environment. They are also a fundamental element of democratic debate based on statistical evidence. It is, however, not easy to obtain quality statistics in Africa, particularly through the agricultural censuses which are at the center of the national systems of agropastoral statistics of African countries. Several international and institutions (FAO, Afristat, Etc) agree that for this quality to be guaranteed, the risks of errors must be reduced in all stages of the census, the design of the methodology and the technical documents for dissemination and archiving of results. The scientific questioning underpinning this article is how to reduce the risk of errors in carrying out agricultural censuses in sub-Saharan Africa? Thus, its objective is to show how to reduce the risk of errors in the realization of an agricultural census in an African country, then identify the determinants. The study identifies the main determinants by relying specifically on data from the two censuses conducted in Cameroon. Two methods of analysis will be used in this article. Descriptive analysis and systemic analysis. The descriptive analysis will consist of describing the different indicators related to all of a census. This will be done by means of the crossed tables. Next, we will try to identify the determining factors of reduction of the risks of errors thanks to a systemic analysis. The comparative approach between the two censuses studied will be clearly highlighted. In the light of the results of the study, an advocacy will be made towards the actors in charge of the questions of the realization of the agricultural surveys and censuses, for a better answer of their needs in the planning of the big operations of agricultural statistics.

**PP216: Assessment of gender-based food security constraints along the cassava value chain in the eastern Democratic Republic of Congo using the Oaxaca-Blinder method
(Abstract Id: A5-7-033)**

^aGuy Simbeko Sadi and ^bChristian Kamala Kaghoma

^asocio economy impact evaluation, International Institute of Tropical Agriculture (IITA),
Bukavu/South-Kivu, Democratic Republic of the Congo (DRC)

^bEconomy, 1Catholic University of Bukavu (UCB), Bukavu/South-Kivu, Democratic
Republic of the Congo (DRC)

guysimbeko@gmail.com, kamala.kaghoma@ucbukavu.ac.cd

Cassava production playing a key role in improving household's food security and income in Democratic Republic of Congo. However, cassava productivity and profitability remains low compared to land potential and the high household proportion depending on it. A wide gap is observed between men and women household in term of food security gain along the value chain. Indeed, there are studies indicating that while women access resources (financial, physical, informational, etc.) in the same way as men, they are 20% more productive, can feed more than 30% of the world's population, and a high propensity to gain relative to men (Giziew, 2014, FAO, 2013, IFAD, 2013, BRIDGE, 2013, USAID, 2013, CGAIR, 2013, FAO, 2013). This is not the case in South Kivu. Among the reasons that would affect the profit of women is the small size of the land, age, women's access to agricultural credit, inputs, level of education, household size, low level of information on farming techniques, lack of infrastructure etc. (Balika 2014, Tegbaru 2015, Anna Laven 2012 and IITA 2013). However, one of the major shortcomings of studies in DR Congo and especially in South Kivu nowadays is the lack of understanding of the nature of this difference in profit and food security between men and women households. Since these studies are based on theoretical approaches, the analysis of the gender issue in the value chain through rigorous econometric methods is necessary. Thus, this study focuses on the question of what is the effect of gender on food security and profit along the cassava value chain in South Kivu? This study assumes that equal access to resources (physical, financial, human, etc.) would be a factor that could improve profitability in the cassava value chain in South Kivu. This study aims at documenting gender related constraints and their effects on benefits earning along the cassava value chain in Eastern of Democratic Republic of Congo, specifically in Walungu territory. Cross-sectional data were collected randomly across different actors along the value chain including 274 producers and 66 traders out of which 188 males and 152 females. This article introduces the R package *oaxaca* to perform the Blinder - Oaxaca decomposition, a statistical method that decomposes the gap in mean outcomes across two groups into a portion that is due to differences in group characteristics and a portion that cannot be explained by such differences. Although this method has been most widely used to study gender and race based discrimination in the labour market, Blinder- Oaxaca decompositions can be applied to explain differences in any continuous outcome across any two groups. Empirical results reveal that age, access of market information, landholding of household head explains significantly food security and profitability among producers while access to credit, market, storage and land constraints women's profitability in production and trading. Efforts should be made to promote access of famers to land, storage, market and credit in order to enhance profit of famers thereby reducing their propensity of falling below the poverty line.

**PP217: Gender Inequality and its Prevalence in Indian Dairy Sector: A Look Over into the SDG-5
(Abstract Id: A12-13-005)**

Jagruti Das, Aniketa Horo and Ajmer Singh

Division of Dairy Economics, Statistics and Management, ICAR- NDRI, Karnal,
Haryana, India
Department of Economics and Sociology, PAU, Ludhiana, Punjab, India
jagrutidas178@gmail.com, vandana.horo@gmail.com, ajmerskundu@gmail.com

Gender equality is a fundamental human right and is a prerequisite for sustainable development forming the basic essence of SDG-5. It clarion calls for valuing unpaid domestic work too. It enforces on equal participation and equitable opportunities in decision making and ownership of assets in all spheres of social, political, economic and public spheres. The Indian Economic Survey 2017-18 says that with men migrating to the cities, there is 'feminization' of agriculture sector, with increasing number of women in multiple roles as cultivators, entrepreneurs, and laborers. In India, 85% of rural women are engaged (not employed) in agriculture, yet only about 13% own land and other assets related to the activity. The trend of feminization in India especially in the spheres of livestock production and animal husbandry had started long back even before the advent of Operation Flood in the 1970s. As of recent times, about 70% of the workers, 80% of food producers, and 10% of basic food stuff processors relating to the livestock sector are women (<http://www.wikigender.org>). Though, their considerable involvement and participation, significant gender gaps exist in access to technologies, credit, information, inputs and services owing to inequities in ownership of productive assets including land and livestock. Women constitute about more than 60 per cent of labour force engaged in livestock sector. Their role within the livestock system varies from region to region induced by social, cultural and economic factors (Patel et.al, 2016). It can thus be stated that a rural Indian woman works for far more hours than their male counterparts but at the same time is less self-reliant. Lack of self-reliance aggravates dependency amongst the rural women thereby hindering their empowerment at household level itself. This paper aims at finding the status of women, inequalities, constraints faced by them and paths to eliminate their adversities in the rural Indian dairy sector within the SDG framework.

Recognition and support to women's roles as livestock owners, processors etc.; needs to be unified along with their decision-making capabilities, which would enhance the women's economic and social empowerment providing a way to break the shackles of poverty.

**PP218: Women in Agriculture: A Study of Lanjia Soura Tribe in Gajapati District,
Odisha
(Abstract Id: A7-9-002)**

Junas Sabar, Women's Studies Research Centre, Berhampur University, Odisha, India
junas143@gmail.com

This paper discussed about women in agriculture of Gajapati district. Gajapati district is tribal dominated district of Odisha i.e., 53 percent population of the state average. The Souras is a vulnerable primitive group in Gajapati district as well as Odisha. The Souras are plains depend on their wet cultivation, wage earning and selling firewood for their survivable and the Soura are also depend paddar, hill, or forest. The hill Soura are practice shifting cultivation, mixed farming cultivation; terraced cultivation on the hill slopes and collection firewood is the main occupation of the Sabara or Soura women which provides them minimum sustenance throughout the year. Both men and women are collect firewood but the collection of Mahula flowers is done exclusively by women and children.

**PP219: Assesment of drumstick leaves supplementation during iron deficiency Anemia
in adolescent girls: Pilot study
(Abstract Id: A5-7-025)**

Neelu Vishwakarma, Rashmi Shukla, Pramod Sharma and Akshata Tomar
Krishi Vigyan Kendra, JNKVV, Jabalpur, India
neeluvishwakarma537@gmail.com

Introduction: Adolescence is the period of most rapid growth second to childhood. Nutritional deficiency, especially iron deficiency is the most common etiological factor for anemia, particularly in adolescent girls when the requirement for iron increases tremendously to physiological need. Their socio-economic situation, consumption pattern, food habit are affecting their health and nutrition as well as their cognitive development and during the period. **Objective:** The objective of the present study is to analyze the effect of supplementation of drumstick and amaranth leaves powder. Also it is aimed to estimate the prevalence of anemia among school going girls to associate it to their social profile and nutritional status. **Materials and methods:** A study was conducted during the year (2016 – 2017) on farm trial on Drumstick (*Moringa oleifera*) dry leaf powder as daily dietary supplement among 20 anemic adolescent girls in Nutri Smart Village (Sihoda) and Tiwarikheda under Shahpura and Panagar Block, Jabalpur District. The demographic profile along with Iron profile levels i.e. blood hemoglobin estimated among 40 adolescent girls aged 10 to 18 years, in schools at Nutri-smart village. Selected 40 adolescent girls divided two groups (20 from each village). One group was given 50g fresh matured green leaves of drumstick and second group received dry leaves powder. Drumstick(*Moringa*) leaves given each selected anaemic girl for adding in daily food as supplement provided at Anganwadi centre. Blood hemoglobin level observed at baseline and after three months post intervention. Percentage change was estimated separately for two groups and compared using t-test for two independent samples after checking assumption using Shapiro Wilk test and Levene's Test. **Results:** The mean age of adolescent girl was 14.32 ± 0.86 years. The mean blood hemoglobin of the GL group before supplementation was found to be 7.9mg/dl and 8.2 mg/dl in DLP group. The mean blood hemoglobin of the GL group after supplementation was found to be 13.6 mg/dl and 11.2mg/dl in DLP group. Within subjects, there was statistically significant increase blood hemoglobin was observed in both the groups separately. There was statistically significant change observed between the groups ($p < 0.001$). **Conclusion:** It is concluded that supplementation of green drumstick leaves (60g) and dry drumstick leaves powder (10g) per day for three months significantly increased Hb level (13.2g and 11.6g). The supplementation of green drumstick leaves powder better perform as iron supplement as compare to dry drumstick leaves. Green drumstick leaves may certainly help to overcome anemia and improve the Hb level of the adolescent girls especially in rural India.

PP220: Estimating the demand function for rice in the Philippines
(Abstract Id: A4-6-008)

Precious G. Sumabat
Department of Economic Sector Statistics Service, Philippine Statistics Authority,
Quezon City, Philippines
p.sumabat@psa.gov.ph

Fifty percent of the gross output of the Philippine agriculture sector is mainly contributed by the crops sub-sector. Rice production, in particular, is the top grosser among the agricultural crops contributing for about 20 percent in the total agricultural economy. Availability of basic food, specifically rice, is always one of the most controversial issues in the Philippines. Because of this, several initiatives and research studies were done to address rice issues. For instance, the Department of Agriculture (DA) implemented programs to meet the staple food needs of the Philippines, and make them accessible, affordable, safe, and nutritious. Programs like this is in line with the Food and Agriculture Organization (FAO) programs on food security. Considering that rice is a staple food of Filipinos, the importance of examining its market demand could not be overemphasized; thus, the conduct of this research. This paper aims to evaluate the demand for rice and the factors that influence it, such as its

own retail price, disposable income, retail price of corn, population as a proxy variable for the number of buyers and time trend as a proxy variable for tastes and preferences. Specifically, the study aims to know the behavior of the Demand for Rice, Price of Rice, Disposable Income, and Price of Corn; determine whether there is a significant relationship between the dependent variable and independent variables when taken individually and collectively; measure price, income and cross elasticities of the Demand for Rice; determine the structural stability of the parameters; and determine if there is a long-run or equilibrium relationship between the Demand for Rice and the identified determinants. This research study will be using a descriptive-causal research design. The source of data will be taken from the Philippine Statistics Authority (PSA). The diagnostic tests to be used will be: Unit Root Test, Test for Autocorrelation, Test of Significance, Goodness of Fit, F-test, Test for Multicollinearity, Test of Correlation, Normality Test, Structural Stability Test, Regression Specification Error Test, White Heteroskedasticity, and Test for Cointegration. The statistical testing will be facilitated through the use of an econometric software, E-views version 7. The study is deemed beneficial to various institutions and researchers. The results of the study may provide information to the policy makers of the DA particularly the Rice Banner program and agencies like the National Food Authority (NFA) in formulating policies and interventions such as price regulation, protection policy agreements, and production-related programs that could sustain the increasing demand for rice in the country. This can serve as a reference to organizations like the National Federation of Palay and Corn Farmers and Other Cereal Grains to monitor their production level and prices. Information that can be obtained can be used for price determination. The regression model that will be derived from this study can be of use for agricultural policy-makers in forecasting the future demand for rice in the Philippines. Finally, this can also be of use to future researchers who may conduct related studies. The results may serve as their baseline data.

**PP221: Identifying efficient rainfed production zones for crop planning in India - An agro-climatic analogue approach
(Abstract Id: A4-6-043)**

^aB.M.K. Raju, ^aC.A. Rama Rao, ^aR. Nagarjuna Kumar, ^aK.V. Rao, ^aG. Ravindra Chari, ^bS. Bhaskar, ^aA.V.M. Subba Rao, ^aM. Osman, ^aJosily Samuel, ^aM. Srinivasa Rao, ^cV.V. Sumath Kumar and ^aN. Swapna

^aDARE, ICAR-CRIDA, Hyderabad, India

^bDARE, ICAR-NRM Division, Delhi, India

^cDARE, ICAR-NAARM, Hyderabad, India

bmkraju@yahoo.com, car.rao@icar.gov.in, rn.kumar@icar.gov.in,
kv.rao@icar.gov.in, gcravindra@gmail.com, adgagroandaf@gmail.com,
avms.rao@icar.gov.in, md.osman@icar.gov.in, s.josily@icar.gov.in,
ms.rao@icar.gov.in, sumanth_vv@yahoo.com,
swapna.nimmagadda@yahoo.com

India is a leading producer of many agricultural commodities, yet the country is not so well placed in terms of productivity. Yield growth and thus production jumps are required more in case of pulses and oilseeds given the country's dependence on imports to meet domestic requirements and also their role in achieving the poverty and nutrition related sustainable development goals. Though overall yields at country level is low there exists huge variability at regional level. Farmers of some regions are excelling in producing some crops. The regions have specialized in those crops with high yield efficiency. Identifying crop-wise zones which are operated at high efficiency and showing soil and climate suitability will enable the planners and policy makers to develop and recommend suitable crop plans for different parts of the country. In view of this the present study made an attempt to assess the efficiency of different production zones at district level for 17 important rainfed crops separately. Currently relative spread index (RSI) and relative yield index (RYI) are being used to identify efficient production zones of a crop. However, RYI does not take into account the natural resource endowments such as soil, climate, irrigation while comparing yields and RSI may,

sometimes, not reveal real spread. It is therefore proposed to use a threshold value for area sown (say 20,000 ha) and all the districts having area more than that in the crop under study are considered as major districts for the crop. While assessing efficiency, yield of a district in a crop need to be compared with districts where similar resources are made available to the crop. Resources available to the crop can be divided into two groups (i) Agro-climatic factors: climate, soil, irrigation and season (kharif/rabi), etc. (ii) Factors of efficient management: adoption of technology, optimum and timely nutrient use, etc. The districts growing a crop are divided into a few groups by identifying agro-climatic analogues with the help of a statistical tool, multivariate cluster analysis using agro-climatic factors as clustering variables. The intra-group variation in yield was then attributed to differences in factors related to management. Highest yield within a group is regarded as potential yield for the remaining districts in the group. Yield efficiency (E) of a district for a given crop is then computed as a ratio of yield of the district and potential yield in the group to which the district belongs to. The field crops viz., rice, sorghum, pearl millet, maize, finger millet, chickpea, pigeonpea, blackgram, greengram, lentil, groundnut, soybean, sunflower, rapeseed & mustard, sesame, castor and cotton are included in the study. Finally major districts of each crop are divided into 4 zones (separately for rainfed and irrigated) by overlaying yield categories over efficiency categories as (i) high yield - high efficiency (ii) high yield - low efficiency (iii) low yield - low efficiency (iv) low yield - high efficiency. Priorities can then be placed on these categories depending on the policy objectives.

**PP222: Leveraging user satisfaction surveys for monitoring use of official of statistics,
and impact of statistical capacity development projects
(Abstract Id: A2-2-032)**

Michael Rahija and Aliou Mballo
Office of Chief Statistician, FAO, Rome, Italy
michaelaustin.rahija@fao.org, aliou.mballo@fao.org

This paper will identify best practices, and examine the ways User Satisfaction Surveys can increase the use of official statistics, and serve as a tool for monitoring and evaluating the impact of statistical capacity development projects. Although many uses of official statistics exist, their utilization for providing insights that can be formulated into policies in pursuit of sustainable development gains is prioritized by national and international funding sources. National Statistical Systems (NSSs) understand well the supply-side of official statistics. Thanks to the efforts of researchers and statisticians there is a large set of academic literature, manuals, and software that help NSSs collect data, and make estimations in-line with well-known statistical methodologies, and international standards. However, the demand side of official statistics is often neglected.

Demand for official statistics stems from the information needs of a variety of institutions. The role of statistics is to answer questions which change overtime due to technological advancements, market changes, cultural dynamism, etc (1). Users of official statistics often lament that they lack the information needed to design, implement, and monitor the impacts of policies. In this regard, many NSSs carry-out USSs to gain insights regarding the profile of users, their main uses, perceived shortcomings in terms of content, quality, and dissemination, as well as receiving feedback. The results are then used to better tailor statistical products and services. A 2018 report by Aiddata, PARIS21, and Open Data Watch (2) based on the results of a survey completed by 1,042 NSS and national level government staff from 140 low and middle-income countries identified six recommendations for improving use of official statistics. The first three recommendations include improving communications, prioritizing the needs, and soliciting feedback from domestic users. The next three recommendations address the role of international development partners calling for improved monitoring, accessibility and prioritizing the use of official statistics. USSs are a cost-effective tool which can be used by NSSs and international partners to implement these recommendations. With major capacity development initiatives such as the 50x30 initiative(3), standardized USSs are needed

to maximize the return on investment in statistical capacity development as well as monitor impact. Additionally, standardized USSs would provide comparable results across countries which would help identify the most effective strategies and approaches. By reviewing publically available USS reports from NSSs and international agencies, as well as primary data collected by FAO, this paper will identify best practices, and key results. The former will cover the sampling strategies, and variables measured. The later will highlight the most widely applicable results, and key recommendations for improving the use of official statistics.

(1) https://unstats.un.org/unsd/publication/SeriesF/SeriesF_88E.pdf

(2) https://docs.aiddata.org/ad4/pdfs/Counting_on_Statistics--Full_Report.pdf

(3) <http://www.data4sdgs.org/50by2030>

PP223: Long run equilibrium between Gambia's exports, imports and GDP using econometric modelling (Abstract Id: A4-6-057)

^aMawdo Gibba and ^bK.K.Saxena

^aEconomics and Statistics, Gambia Bureau of Statistics, , Banjul, Gambia

^bDepartment of Statistics, University of Dodoma, Dodoma, Tanzania

mawdogibba88@yahoo.com, saxkk@yahoo.com

An attempt has been made in this paper to investigate the long run equilibrium and short term disequilibrium relationship between Gambia's exports, imports and GDP along with to investigate the presence of shift in the magnitude of the error correction in the short run in order to examine the efficacy of the trade policy of the country. The analysis has been done on the basis of a subsample from 2006Q3-2015Q4 out of a full sample 1995Q1-2015Q4. The Johansen cointegration test, Granger causality test, Impulse Response Function (IRF) and Forecast Error Variance Decomposition (FEVD) methods were applied. Stationarity test was conducted on the time series data of export, import and GDP. The ADF test and PP test results indicate that the time series for the period 2006Q3-2015Q4 are integrated of order one. Therefore; imports, exports and GDP are integrated in order one which allows for cointegration test to be executed in this research. Before executing the analysis for cointegration, the lag length for the VAR system is determined by the Akaike Information Criterion (AIC) and Schwarz Bayesian Information Criterion (SBIC). The results suggest the use of 2 lag in the VAR system, which ensures that the residuals are independently multivariate normally distributed and homoscedastic too. Therefore, the VAR system is estimated with two lag of each variable. The Johansen's cointegration results suggest that imports, exports and GDP are cointegrated and these macroeconomic variables follow a common trend indicating that there is a long run relationship between imports, exports and GDP. These results further suggest that imports seem to have positive effect on economic growth of the Gambia but its coefficient is statistically nonsignificant; whereas exports have strong significant positive effect on economic growth of the Gambia in the long run. It has been concluded that export is a granger cause to GDP and its causal relationship is unidirectional but not vice versa. Results also show that export is a granger cause to imports and its causal relationship is unidirectional but not vice versa and finally GDP is a granger cause to imports and its causal relationship is unidirectional but not vice versa. The impulse response functions (IRFs) indicates that when there is a shock to imports, GDP will respond both positively and negatively both in short and long run. Furthermore, the existence of cointegration implies the existence of Granger causality at least in one direction. The coefficient of the second lag of exports in the GDP equation is statistically significant, indicating the existence of short-run causality from exports to economic growth.

PP224: Measuring market imperfection: Asymmetric price transmission in oilseeds

(Abstract Id: A4-6-040)

T.K. Immanuelraj, Shiv Kumar and Abhimanyu
Market Trade and Institution, ICAR-National Institute of Agricultural
Economics and Policy Research, New Delhi, India
ecokingsly@yahoo.co.in,
shivkumardull@gmail.com, abhimanyu.jhahria@icar.gov.in

The existing institutional and infrastructural constraints in agri-marketing system severely disincentivise farmers, is not undeniable fact. Because they limit perfect price transmission and the market efficiency, which is necessary condition for the welfare of the farmer and the betterment of the society. This study has taken the case of groundnut oil marketing chain, to capture the extent of market imperfection by measuring the asymmetric price transmission using monthly price series secondary data from 2009 to 2017. Moreover, the results of the groundnut market chain would be equally applicable for all other important oilseeds market chain, as they all share the common production and consumption environment. India's import demand for edible oils have continued to increase over the years. Of late, edible oil imports is around 15 million tonnes in 2016-17, accounting for nearly 70 per cent of total consumption in the country. The major components of edible oils are palm and soft oils. The palm oil is the cheapest among all the edible oils, accounts two-thirds of total edible oils import, mainly sourced from Indonesia and Malaysia. The area under oilseed cultivation has stagnated between 26–28 million hectares over the last several years. There has been a conscious attempt in recent years to improve production by adjusting price parity of oilseeds through increase of Minimum Support Price (MSP), implementing schemes like National Mission on Oilseeds and Oil Palm, regulating import prices through tariff rate, and taking up various other measures related to technology, institutions and policy. The co-integration results reveal that all the market price series were co-integrated. The results of granger-causality test shows that bidirectional causality was found between palm oil wholesale price and groundnut wholesale price, implying both prices are interdependent and move in tandem. However, at the producer and consumer end, uni-directional causality was found signifying that groundnut seed price and groundnut oil retail price were determined by groundnut oil wholesale price. The special significance of the study is rejecting the usually followed assumption of symmetric price transmission using Engle Granger Threshold Co-Integration. The results revealed that though there is long-run equilibrium relationship found between the price series of groundnut oilseed and wholesale groundnut oil, adjustment to the disequilibrium was not symmetric as assumed by usual co-integration studies. The positive shock coefficient was estimated to be -0.07 and insignificant, implying that if the groundnut oilseed price increase, immediately that shock (disequilibrium) transmitted to wholesale groundnut oil price, but the adjustment or the rate at which the disequilibrium is eliminated is only seven per cent, so the wholesale price stays high for long time. However, if the groundnut oilseed price decreases, wholesale oil price also decreases, but disequilibrium is eliminated speedily at the rate of 50 per cent. So, it comes back to equilibrium. The conclusions emerging from the study is that market is not working favourably for farmers in case of oilseeds. Market reformation is needed immediately to correct the price signals, and improve the market system.

PP225: Nutrition challenges in Kenya
(Abstract Id: A3-15-001)

Paul Maina Nderitu
Food and Nutrition Statistics, Kenya National Bureau of Statistics,
Nairobi, Kenya
pnderitu@knbs.or.ke

Malnutrition remains a challenge to national development in Kenya. Current data indicate that about

1.5 million children under the age of five years (26%) are stunted while nearly 4% are wasted and 11% are underweight. The Global Nutrition Report 2016 categorizes Kenya as one of the countries making good progress in reducing the prevalence of stunting. However, the national estimates mask progress within sub regions due to socio-economic variations. The Government has made a commitment to improve food security and nutrition as articulated in the Constitution and in national development plans. The National Food and Nutrition Security Policy (2011) provides an overarching framework covering the multiple dimensions of food security and nutrition. The policy has three main objectives: to achieve adequate nutrition for the optimum health of all Kenyans at all times; to increase the quantity and quality of food available, accessible and affordable to all Kenyans at all times; and to protect vulnerable population using innovative and cost effective safety nets linked to long term development. Data from nutrition studies conducted in Kenya show that the prevalence of stunting showed no improvement between 1987 and 2005. However between 2005 and 2014 the prevalence of stunting declined by 1.7% per year, an average annual rate of reduction of nearly 5%. Obtaining an accurate picture of the drivers of improved nutritional status remains a challenge for Kenya. Under-nutrition is a multi-sectoral challenge that is open to various interpretations as a health, economic growth, intergenerational rights, or humanitarian issue. Therefore a broader set of nutrition indicators reflecting nutrition-sensitive interventions from agriculture, education and social protection, should thus be taken into account to ensure an assessment of multi-sectoral approaches to nutrition. This multi-sectoral nature of nutrition raises challenges for implementing programmes to improve nutrition and increases the importance of high quality implementation monitoring and impact evaluation. Building systematic evidence about the processes related to intersectoral and multisectoral integration of actions is key to addressing undernutrition in a more effective and efficient way. In this paper we demonstrate how to overcome the vicious cycle of malnutrition through provision of quality statistics for policy and decision making. The paper will cover the following: analysis of current nutrition challenges in the country, the problems that need to be addressed such as -lack of a repository for multi-sectoral datasets to create and operate an information platform for nutrition, low capacity to monitor national objectives on preventing under-nutrition and monitoring nutrition investments and limited capacity of policy makers and programme planners to make better use of evidence in policy making. The proposed action will be to create a platform to raise questions governments need to answer to develop or refine their policies and programmes. The Methodology will be bringing together and analyzing information and data from all sectors that can influence nutrition such as health, agriculture, food security, education, water, sanitation and social protection.

**PP226: Post-independence India: Analysing impact of credit on Indian agriculture
(Abstract Id: A4-6-024)**

Saket Kumar Sharma and O P Mall
DSIM, RBI, New Delhi, India
saketkumar@rbi.org.in, saketrbi@yahoo.co.in

This paper attempts to analyse the issues in agricultural credit as inadequacies of agrarian finance had more than a century of tortuous history in India. The preliminary results indicate that the credit delivery to the agriculture sector continues to be cause of concern. The Indian agricultural credit system as it has emerged, has been a product of both evolution and intervention and symbolises the system's response to the stimuli from continuing dissatisfaction with credit delivery. The concern for food security and the need for building up buffer stocks, which guided the Green Revolution, created both enhanced and diversified type of credit requirements for agricultural production. In India, a "supply-leading approach" to the institutional development for agriculture credit has been followed. As found by the Reserve Bank, as early as in 1936-37 that almost the entire finance required by agriculturalists was supplied by money lenders and that cooperatives and other institutional agencies played a negligible role part. And all these laid the foundation for building a broader credit infrastructure for rural credit was laid by the Report of the All India Rural Credit Survey (1954). The

report, apart from visualising cooperatives as an exclusive agency for providing credit to agriculture, urged a well defined role for commercial banks in delivering credit for agriculture in specialised areas, such as marketing, processing, storage and warehousing. Towards this end, the survey report recommended establishment of the State Bank of India and through it, extension of commercial banking facilities to rural and semi-urban areas. Thus, concern with the inadequate extension of agricultural credit had a significant role in the founding of both the Reserve Bank of India and transformation of the Imperial Bank of India into the State Bank of India. A review of performance of agricultural credit in India reveals points out that though the overall flow of institutional credit has increased over the years, there are several gaps in the system like inadequate provision of credit to small and marginal farmers, paucity of medium and long-term lending and limited deposit mobilisation and heavy dependence on borrowed funds by major agricultural credit sources. These have been major implications for agricultural development as also the wellbeing of the farming community and calls for efforts are therefore required to address and rectify these issues. This paper also inter- alia tries to explore whether banking sector reforms have improved the share of net bank credit to the agricultural sector, whether there has been neglect of agricultural sector by institutions and possible reasons thereof (like adoption of profit-oriented norms), impact of credit subsidy on supply of agricultural credit, impact of the restructuring branch networks. The study also analyses role of financial intermediaries in influencing agricultural performance. After describing the evolution and functions of the financial sector, we construct a set of Vector Autoregressive (VAR) model and Vector Error Correction Models (VECM) to evaluate the strength and direction of the links between measures of formal intermediation and agricultural aggregates.

**PP227: Statistical credibility of model specification for policy making
(Abstract Id: A4-6-055)**

Amit Kumar Vasisht
ICAR Headquarters, New Delhi, India
amitvasisht@rediffmail.com

In most areas of research, the researchers have a tendency to take the data as given and build a statistical model based on it. In this they are often guided by what data are readily and easily available. The data on hand may be just a part of a larger data set being thrown up by an underlying data generating process. It may happen that the variable being modelled is possibly influenced by some of the other omitted variables for which data are either not collected or not available. If one errs by ignoring some variables that play a crucial role in generating the data then the information content of the data actually used could be less than sufficient to understand the structure. One should not omit a relevant variable just because the data on that are not available. One must then collect the needed data than omit the variable. Alternately, if such data collection is very costly or impossible one can use a proxy. How good a proxy is determined by the hypothesised or assumed degree of correlation between the true variable and the proxy. The higher this correlation the closer will be the results to the true regression with the relevant variable. There are certain steps that constitute scientific credibility of statistical inference. The entire scientific edifice is built on the assumption that the maintained hypotheses are true. This scientific credibility of the maintained hypotheses has to be achieved through the principles of advocacy. Credibility is to be achieved through reasonableness of the assumptions made. The notion central to statistical modelling is that there is an underlying “structure” characterising the phenomenon generating the data. That “structure” requires different elements of “information”. As a part of that information comes from the data we collect, what data one must collect depends on what aspects of the structure we want to understand. There is a great need to understand the “structure” of the underlying economic model of data generating process. Sample information is only one type of information, and one needs to supplement that sample information with some prior information. Unless proved otherwise that structure is possibly an integrated structure, and every part of the data may have information on that structure. To understand fully the

underlying structure that generated the “limited data” on hand it may, therefore, be necessary to understand other data generated by the same data generating process. This paper makes some observations about the statistical credibility of model specification for policy making.

**PP228: Text analytics of the queries raised at kisan call centres in Tamilnadu
(Abstract Id: A4-6-022)**

Yashavanth BS and Sreekanth PD
Information and Communication Management Division, ICAR-NAARM,
Hyderabad, India
yashavanthbs@gmail.com, sreekanth@naarm.org.in

In order to harness the potential of Information and Communication Technology (ICT) in Indian Agriculture, the Ministry of Agriculture and Farmers’ Welfare, Government of India launched the ‘Kisan Call Centres’ scheme on January 21, 2004. Though this scheme is active for more than a decade and is popular among farmers since its inception, the queries raised by farmers which are recorded by the Farm Tele Advisors have not been studied. This study is a first in its kind where the queries raised by farmers are analyzed using text analytics techniques. The data for this study consists of district-wise month-wise queries that are raised by the farmers in Tamilnadu state during the agriculture year 2016-2017. The data analysis is carried out in two stages. At first, the frequency data of the queries are analyzed using exploratory data analysis techniques. Later, topic models are fit to the data using Latent Dirichlet Allocation (LDA) technique. The data was cleaned for punctuation symbols and stop words, followed by the exploratory analysis for the frequency of each word appearing in the query. The most of the queries consisted the words “management”, “weather”, “report”, “paddy” and “fertilizer”, each of them appearing more than 20,000 times in the data corpus. The word cloud was plotted to see the relative appearance of these words compared to others. The bigrams were also studied to find out the pair of words which appear very often. It was found that the bigrams “weather report” appeared the maximum number of times followed by “fertilizer management”, “black gram” and “market rate”, each appearing more than 10,000 times in the data corpus. The bigram network plots were also drawn to study the relationships between/ co- occurrence of the words. For fitting topic models, the collection of queries for each district for each month is considered as a text document. Since there are 30 districts in Tamilnadu and the study period has 12 months, a collection of 360 documents was obtained. The topic models were developed for this text corpus using LDA. LDA assumes that the number of topics is already known. We tried different values for the number of topics and the optimum value was obtained by using the Harmonic Mean criteria. It was observed that there are 9 topics for the data corpus and the top 6 words that are most common with each topic are found out along with the probability of that word being generated from that topic. The probability that each document belongs in each topic is also found out. It was observed that there are many documents that belong to each topic as well as some documents not belonging to any topic indicating that documents are being well discriminated. Probability distribution within each topic was also found out which tells us each document’s probability of belonging in that topic. The results of this study prompts for further investigations using Natural Language Processing techniques to analyze query texts to address the needs of farmers.

**PP229: Use of agriculture data for policy making
(Abstract Id: A4-6-042)**

Raju Pokhrel
Central Bureau of Statistics, Central Bureau of Statistics, Kathmandu,
Nepal
rhlpokhrel2072@gmail.com

This paper deals with the prevailing practice of the use of agriculture data for policy making in Nepali context. Nepal is an agricultural country with two third of the total population directly involved in farming. Most of the people in Nepal live in rural area with subsistence farming. Commercialization of farming is still not noticeable in national figure.

Massive migration of male labour force out of the country has forced the agriculture sector to be feminised. The role of these women workforce for the agriculture as well as rural development is crucial in this context. Rural development along with agriculture is a key to economic growth and prosperity for Nepali people. Agriculture plays a dominant role in national economy. The contribution of agriculture in GDP is still significant though the contribution of non-agricultural activities is gradually increasing. So, the policies and programmes focused on the enhancement of agricultural sectors are very vital for the boosting of national economy. It requires evidence based policy making for the improvement of agriculture sectors like other sectors. Policies and programmes formulated and then implemented in the absence of evidence or supporting data are futile. Outcomes of agricultural investment largely depend on the policies and programmes designed and implemented on the basis of agricultural data generated from census and surveys. This paper attempts to explore the prevailing practice of making use of agricultural data for policy making in Nepali context. Data from secondary source like agriculture census and surveys have been collected and then is explored in line with their real utilization in policy making and its implementation. For this, data from various government agencies like ministries and departments are used to explore and identify the prevalent scale of the use of agricultural data for policy making and implementation. The findings of the research are useful for the statisticians, economists, researchers, academicians, general users and so on.

**PP230: An Empirical Analysis of Free Trade Agreement on Import of Commodities
from Africa to China: Policy Considerations and Recommendations
(Abstract Id: A12-13-002)**

Christopher Belford
Department of Agricultural Economics and Development, Chinese
Academy of Agricultural Sciences, Haidian, China
cbelford@utg.edu.gm

Africa and China, at present times, enjoys close relations in numerous areas of cooperations including trade. The Chinese government over the past years have granted trade concessions including tariff elimination to thirty (30) African countries. Hence the motivation to explore how Free Trade Agreement in import tariff of commodities and services from Africa to China can be beneficial to Africa in its quest to improve the livelihoods of its citizenry. The study had to two (2) policy scenarios: firstly, an elimination of import tariffs on commodities and services imported from African countries to China and secondly, a reduction by 50% of import tariffs on commodities and services imported from Africa to China. The paper critical assess the economic impact of both policies to empirically determine which of the policy is more beneficial to Africa. This study employed the GTAP 9A database. Data year 2011, to create regional, sectoral and factorial inputs aggregations. The simulation results indicate that an adopting of either policy scenarios will attain some beneficial economic and output variables. An import tariff FTA for goods and services from Africa to China is beneficial for Africa irrespective of which of the two (2) policy scenarios are implemented.

**PP231: Group Farming–Sustainable way of livelihood; mean to end poverty and
hunger at villages
(Abstract Id: A5-7-038)**

Sreeni K R

Amrita SeRve, Amrita University, Kollam, India
krsreeni72@gmail.com

Amrita Sadivaial Vyavasayam Kulu comprising of twenty farmers, belonging to the tribal community of Irulas, initiated organic farming at Sadivaial, a tribal hamlet in the suburbs of Coimbatore. Amrita SeRve (Self Reliant Village project) planned and help the farmers from tillage, collection of seeds, preparation of manures and pesticides, introduction of technological innovations, modern methods in production and processing of raw materials till the marketing of products. With the aid of mobile apps and blogs we have helped these farmers to sell their products. Villages are the basic foundation of our Indian society; hence changes should be initiated from the villages. Strengthening our food security system at the micro-level is of utmost importance. No two villages have identical problems, but to sort out the food security problem of the future we have to revive the agriculture system that once prevailed. Zero Hunger is United Nations Sustainable Development Goal #2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture. Two indicators selected by the UN to measure progress against this goal are the average income of small-scale food producers and the proportion of agricultural area under productive and sustainable agriculture. Against this backdrop, this paper explores the case of organic agriculture in a tribal village in Tamil Nadu. Amrita SeRve is an initiative launched by the Mata Amritanadamayi Math. One of its main objectives is to motivate farmers to make the transition to organic agriculture and hand-hold / mentor them as they make the switch. This experiment of 'agri' + 'culture' i.e. farming based on culture, was tried at Sadivaial by me. It united the farmers in a pristine culture of sharing, caring, protecting and selling paddy together. It invigorated and enhanced the social engine of the village with mutual trust. It helped identify and weed-out wrong-doings in the socio-agro-economy of their community. This empowered them to know and bargain for their rights. This was clearly demonstrated in their farming practices, done without any instance of money-lending or of borrowing loans from banks. Also, it is heartening to see that alcoholism is now on the decline!

PP232: Harnessing from the youthful demography whilst ensuring food security and addressing unemployment in Uganda
(Abstract Id: A5-7-003)

Bwanika Charles, Programs Department, Giving Children Hope
Initiative, Mityana, Uganda
bwkcharlie@gmail.com

Youth account for 75% of Uganda's population with 1,300,000 entering the labour market annually (Uganda Analytical Report on Youth Employment, 2014). They offer a dynamic work force that is innovative; have a high uptake of technological know-how and the ability to take on significant levels of risk. The Agriculture sector presents a huge opportunity for the creation of employment to absorb the youth and ensure achievement of food security for future generations. However, the sector is yet to fully exploit the potential of the youth and it remains largely unattractive. The situation is exacerbated by perception of agriculture as a career of last resort, Information on access to markets, factors of production including land and financing remain extremely limited hindering adequate engagement of the youth in agriculture. Majority of the population that's 80% depend on agriculture as a livelihood though still predominantly practise traditional and subsistence farming practices. The decreasing number of young people involved in farming as an occupation / business is a national signal of distress in the agricultural sector. This is already negatively impacting on the economy. The low interest in agriculture among the youth could partly be attributed to the public sector systems that have concentrated more on production with limited value addition, processing and marketing. This highlights the great challenge of youth unemployment but can also be seen as an opportunity for them to become the engine driving new agriculture and agribusiness enterprises as well as rural transformation. Global population is expected to increase from 7 billion to 9 billion by 2050, with youth (aged 15-24) accounting for about 14% of this total (ILO, 2014). With the rapidly rising

population, there is an equal increase in demand for food hence worsening the global food insecurity especially in developing countries. As a result, food insecurity has been anchored within the Post-2015 Sustainable Development Goals, that is, Goal 1 - Ending poverty in all its forms and Goal 2 - Ending hunger to achieve food and nutrition security and promote sustainable agriculture (SDG, 2030). Globally, agriculture accounts for 32% of total employment. It is important to focus on the young people as the future of addressing food insecurity even as global youth population increases. The global youth population growth does not seem to be commensurate with the available employment and entrepreneurial opportunities for youth, particularly those living in developing countries like Uganda.

**PP233: Impact of irrigation on food security in India for the a decades
(Abstract Id: A5-7-003)**

Abirami P

Ag. Economics, Tamilnadu Agricultural University, Coimbatore, India
abirami20113@gmail.com

Tamil Nadu has made substantial progress in health determinants in the agriculture sector over a decade and has almost self-sufficient in food grain production. There has been impressive economic progress with achievements in the domain of agriculture contributing significantly.

Ensuring efficient and effective water management through irrigation is essential for raising agricultural productivity and achieving food security. This is a tremendous achievement owing to its small territory and huge population and this was achieved through agricultural the condition of having a highly technical implementation and a modernized version. Irrigation is one of the leading inputs has a direct influence to increase yield, food grains production and plays a vital role in ensuring food security in Tamil Nadu. The present study examined the growth of the irrigated area and its impact on food grain production during a decade. Time series data were used for the study. Different statistical tools such as mean, percentage, linear and exponential growth model were applied for getting meaningful findings. Various technologies have been used for irrigating crops which have contributed to the rapid expansion of the irrigated area. The conventional irrigation methods (Low Lift Pump, Dhone, Swing Basket, Treadle Pump, etc.) were replaced by modern methods (i.e Tube Well and Open Well). In addition, surface water irrigation also sharply declined, losing its importance due to lack of new surface irrigation project and the ineffectiveness of the earlier project. Groundwater covered 55.7 percent of the total irrigated area and major (62%) extractions occurred through Open Wells (OWs).

**PP234: A longitudinal study on the impact of species and age of animals on milk
production in dairy animals
(Abstract Id: A5-7-003)**

^aJ.K. Chaudhary and ^bMedRam Verma

^aDepartment of Animal Breeding & Genetics, Central Agricultural
University, Aizawl Mizoram, India

^bDivision of Livestock Economics, Statistics and Information Technology, ICAR-
Indian Veterinary Research Institute, Bareilly UP, India, vetjitu@gmail.com and
medramverma@rediffmail.com

The age of the lactating animal has important effect on the productive capacity of the animal. The effects of age differ from species to species and breed to breed. As the age of the animal increases, its body functions such as physiological and metabolic activities also increase up to a certain age (mature

age) and then there is decline in these functions. Keeping in view of the above points a longitudinal study was conducted to assess the impact of species and age of animals on milk production in dairy animals. The longitudinal data on milk yield of cattle and buffaloes have been recorded fortnightly interval up to 300 days for the period 2005 to 2014 from the dairy farm of Indian Veterinary Research Institute (IVRI), Izatnagar, Bareilly, Uttar Pradesh. The analysis of continuous longitudinal data on milk yield has been undertaken by using two stage model, linear mixed model and generalized estimating equations (GEE) models. The two stage model was fitted by using Proc ttest and Proc reg. Linear mixed model and Generalized Estimating Equations (GEE) was performed by using the Proc mixed procedures in SAS 9.3. The parameters of interest were species and age of the animal. From the study we found that the base line milk yield was significantly (p value $< .0001$) higher in cattle than buffaloes. The change in milk yield decreases with time and this decrement was more in buffaloes than cattle. After adjusting for baseline age, on average cattle baseline milk yield was about 1.05 units more than buffaloes and after adjusting for species, one year increase in age corresponds to 0.102 unit increases in baseline milk yield. Cattle milk yield change rate was about 0.0009 units greater than buffaloes after adjusting for baseline age and one year increase in age corresponds to 0.0012 units less in milk yield change rate after adjusting for species.

PP235: Analysis of agriculture productivity & incomes of farmers: A Sustainable Development Goals perspective
(Abstract Id: A5-7-003)

Sanjay Kumar and Akhilesh Kumar
SSD, NSO, Ministry of Statistics & PI, New Delhi, India
sanjaypant81@gmail.com, akhilesh.kumar99@gov.in

Agriculture and allied sector is the largest source of livelihoods in India. Almost half of the workforce remains dependent on agriculture however it earns less than one fifth of the GDP. Around two third of its rural households depend primarily on agriculture for their livelihood. It is the second- largest producer of rice, wheat, sugarcane, cotton, groundnuts, fruits, vegetables etc. The output per hectare i.e. agricultural productivity, remains low for many crops when compared to other countries. The productivity of wheat and rice nearly at 3,3034 kg/hectare and 2,400 kg/hectare and the GVA in agriculture per worker nearly Rs.60 only. India, one of the signatory of '2030 Developmental Agenda' is committed toward attaining one of the SDG target related to zero hunger emphasized upon the doubling of agriculture productivity and farmer's income. The present study focuses on the analysis of available data on agriculture productivity and assessment of its impact on farmer's income and Indian efforts toward achieving the SDGs in general and SDG 2 in particular.

PP236: Dimensionality reduction of survey data on women's agency and empowerment in agriculture
(Abstract Id: A5-7-003)

Subash Surendran Padmaja and Vijesh V. Krishna
Agricultural Growth and Development, ICAR-National Institute of Agricultural
Economics and Policy Research, New Delhi, India
subash.sp@icar.gov.in, v.krishna@cgiar.org

Many quantitative assessments on technological change in agriculture overlook the role of women in decision-making, focusing solely on awareness and perceptions of (mostly male) household heads. On the other hand, qualitative case studies on women farmers fails to provide wider picture due to small

sample size. We propose that distilling out the key predictors and indicators of women's agency and empowerment through dimensionality reduction of data on Women Empowerment in Agriculture Index (WEAI) would help quantitative studies by providing depth, without significant addition in the survey cost. To measure empowerment, agency, and inclusion of women in the agricultural sector, WEAI, a survey-based multidimensional index, was developed by the International Food Policy Research Institute (IFPRI), the Oxford Poverty and Human Development Initiative, and the U.S. Agency for International Development (USAID) (Alkire et al. 2013). Although comprehensive and widely used by social scientists, WEAI has certain limitations both at the conceptual and practical levels. One of the biggest challenge at operation level is the number of questions required to estimate the Index. The WEAI module used in the Feed the Future programme is about 10 pages which takes significant time to complete. As of now, researchers have two alternatives if larger and more intensive survey are not possible to be carried out due to time or budget constraints: (i) random exclusion of households, and (ii) use of abbreviated WEAI (A-WEAI) as proposed by Malapit et al. (2017). Through abbreviation, a 30% reduction in overall time of the WEAI survey module is expected. There are, however, no clear indication on how the abbreviation of the instrument and/or exclusion of households would affect the efficiency of the instrument to capture women's empowerment, agency, and inclusion of women in the agricultural sector. Against this backdrop, we propose an alternative method of data dimensionality reduction technique, using both statistical and machine learning techniques. A smaller set of predictors and indicators of WEAI is developed based on statistical tools (e.g., generalized discriminant analysis, low variance filter, high correlation filter etc.) and machine learning algorithms (e.g., random forest, artificial neural network etc.). However, the objective of the study is not only to develop shorter version of the WEAI module compatible for technology adoption/impact studies at the household level, but also to provide a rationale behind the selective inclusion of variables in the survey instrument. A theoretical frame is developed based on the differential explanatory power of variables to capture women's agency in agriculture.

**PP237: Galvanizing action on sustainable development goals in India – Measuring through SDG indicators
(Abstract Id: A5-7-003)**

Akhilesh Kumar and Sanjay Kumar
SSD, NSO, Ministry of Statistics & PI, New Delhi, India
akhilesh.kumar99@gov.in, sanjaypant81@gmail.com

The 70th Session of the UN General Assembly held on 25th September 2015 adopted the document titled "Transforming our World: the 2030 Agenda for Sustainable Development" consisting of 17 Sustainable Development Goals (SDGs) and associated 169 targets, spread over the areas of social, economical and environmental dimension of development. It is a fitting framework which calls attention to the challenges to a sustainable future and organizes world nations' response. India, home to one-sixth of all humanity, is fully committed to 2030 Agenda. The SDGs is already mirrored in India's national development goals and agenda of "sab ka saath, sab ka vikas aur sab ka vishwas". The localization of SDGs is an agenda of central importance as the States are the primary stakeholders in ensuring the success of the 2030 Agenda for Sustainable Development in India. The country has taken proactive steps at the national and sub-national levels to adopt, implement, and monitor SDGs. The preparation of a National Indicator Framework (NIF), leveraging Global Indicator Framework (GIF) especially SDG 2, compilation of SDG Baseline Report, SDG India Index and SDG Dashboard are important exercises not only to track progress but also it serves to identify priority areas and data gaps. However, the efforts are also required to harness and unify the development data to ensure that decisions that are made are effective.

PP238: Integrating the women's empowerment in agriculture index into agricultural household surveys

(Abstract Id: A5-7-003)

^aCarlo Azzarri, ^bAlessandra Garbero, ^aBeliyou Haile, ^cJessica Heckert,

^aRuth Meinzen-Dick, ^cAgnes Quisumbing and ^aGreg Seymour

^aEnvironment and Production Technology Division, International Food Policy
Research Institute, Washington, DC, USA

^bResearch and Impact Assessment Division, International Fund for
Agricultural Development, Rome, Italy

^cPoverty, Health, and Nutrition Division, International Food Policy
Research Institute, Washington, DC, USA

c.azzarri@cgiar.org, a.garbero@ifad.org, b.haile@cgiar.org,
J.Heckert@cgiar.org, dick@cgiar.org, a.quisumbing@cgiar.org,
g.seymour@cgiar.org

Valid measures of women's empowerment are essential for monitoring progress toward Sustainable Development Goal 5 (gender equality and women's empowerment). Standardized women's empowerment indicators are valuable both in impact assessments of interventions aiming to empower women and as part of national statistical systems. The Women's Empowerment in Agriculture Index (WEAI) (Alkire et al., 2013) and the project-level WEAI (pro-WEAI), the newest version of WEAI designed as a diagnostic and impact assessment tool for agricultural development projects (Malapit et al., 2019) measure inclusion and empowerment in the agricultural sector. Both are based on household survey instruments and administered separately to an adult man and adult woman in the household. Although the WEAI has been widely used by researchers and policy makers, the extra time and respondent burden added to already lengthy household survey instruments is a major challenge to increased uptake. For example, the pro-WEAI has been estimated to add between 45 minutes and 2 hours of interview time, depending on the respondent's experience and the enumerator's expertise and approach. In this work we present integrated-WEAI (i-WEAI), a novel approach that is intended to prevent duplication of survey questions (via minor modifications) and reduce overall survey time. This approach allows for the collection of most WEAI indicators in existing agricultural household surveys while minimizing the number of additional questions required. This approach is developed as part of a collaboration between the International Food Policy Research Institute (IFPRI) and the International Fund for Agricultural Development (IFAD). It is embedded into IFAD's standard Research and Impact Assessment (RIA) division questionnaire, which is expected to be used in approximately 24 IFAD impact assessments in the current IFAD replenishment cycle, including gender-focused and non-gender-focused projects. Limited, but targeted, modifications to the RIA standard questionnaire make it possible to compute 7 of the 10 WEAI indicators, or 6 of the 12 pro-WEAI indicators. An additional 30 questions and a 24-hour time allocation module would be required to compute the remaining indicators. The i-WEAI approach does not replace WEAI or pro-WEAI, although it allows for the computation of many comparable indicators with a substantial reduction in interview time compared to administering the WEAI modules separately. It is a promising avenue for collecting standardized data on women's empowerment across a broad range of agricultural household surveys used both to assess project impact and in national statistical systems (such as the 50 x 2030 initiative). This paper will present results from the first study using i-WEAI—an ex post impact assessment of a gender-focused rural microfinance program supported by IFAD in Mali from 2010 to 2019. The paper will address estimates of staff and interview time, as well as other resources required for implementation; explain how i-WEAI indicators are calculated and interpreted vis a vis the WEAI and pro-WEAI indicators; and assess the impact of the project on the i-WEAI indicators. These findings will be used to inform data collection standards for integrating WEAI into agricultural household surveys.

PP239: Measuring Women Workers in Livestock: A Note on the Official Statistics
(Abstract Id: A5-7-003)

Vijayamba R
Economic Analysis Unit, Indian Statistical Institute, Bengaluru
vijayamba1201@gmail.com

There are 400 million rural women livestock keepers in the world. Rural women play a very important role in raising livestock resources that provide nutrition and employment. The objective of this paper is to estimate female livestock work participation rates in India using secondary sources of data. The secondary sources of data that collect information on women workers in livestock raising are National Sample Survey Office's (NSSO) Employment and Unemployment Surveys (EUS), Time Use Survey (TUS), Periodic Labour Force Survey (PLFS), annual Employment and Unemployment Surveys by Labour Bureau and India Human Development Survey (IHDS). Annual Employment and Unemployment Surveys by the Labour Bureau do not allow for complete disaggregation of data to get estimates of women in livestock. The definition of work in IHDS data remains inconsistent and arbitrary to estimate the work participation rates. PLFS data (2017-18) is not yet released. Therefore Employment and Unemployment Surveys (EUS) and Time Use Survey (TUS) by the National Sample Survey Office (NSSO) are used to get female livestock work participation rates. Secondary sources of data undercount rural women in livestock raising due to narrow definition of work, misclassification of workers, investigator and enumerator bias. There are abnormal fluctuations in categorizing women workers in livestock under different categories, specifically in usual subsidiary status and non-workers with livestock raising as a specified activity in the EUS. In the calculation of work participation rates, NSSO does not include those in specified activities because the duration of participation in these activities is nominal. Therefore I calculate augmented work participation rates by including the women in specified activity of livestock raising to address the problem of underestimation of women workers in livestock raising. I consider the NSSO EUS 50th (1993-94), 55th (1999-00), 61st (2004-05), 66th (2009-10) and 68th (2011-12) and pilot time use survey (1998-99) for analysis. Calculation of augmented work participation increases work participation of women in livestock substantially and the increase is higher in northern states because a large number of women engage in domestic duty and livestock raising is considered as an extension of domestic duty. TUS estimates show higher participation of women in livestock raising than the estimates from EUS that is due to the difference in measuring livestock raising as an economic activity. There is a decline in work participation rates of women in livestock raising after 2005.

**PP240: Food security under climate change and rural development in sub Saharan
Africa: The case of Kenya
(Abstract Id: A5-7-003)**

^aRichard Kimitei and ^bFaith Rono

^aResearch, Kenya Agricultural and Livestock Research Organization,
Nairobi, Kenya

^bCrops, University of Eldoret, Eldoret, Kenya
richard.kimitei@kalro.org and fairono96@gmail.com

Sub-Saharan Africa (SSA) has been portrayed as the most vulnerable region to the impacts of global climate change because of its reliance on agriculture which is highly sensitive to weather and climate variables such as temperature, precipitation, and light and extreme events and low capacity for adaptation. Furthermore, the rural populations of developing countries—for whom agricultural production is the primary source of direct and indirect employment and income—will be most affected because of agriculture's direct exposure to climate change. The SSA region accounts for more than 950 million people, approximately 13% of the global population. By 2050, this share is projected to increase to almost 22% or 2.1 billion. Kenya like other African countries is faced with hunger and poverty and these problems are becoming worse. It is estimated that more than 14.3 million people, or 52.3 percent of the population, live below the poverty line. About 52.9 percent of the population in the rural areas and about 34.8 percent of those in the urban areas are poor. It is also

estimated that about 34.8 percent of the rural population and 7.6 percent of the urban population live in extreme poverty. Although a number of development problems have been identified as causing poverty, including lack of education, prevalence of sickness, declining level of school attendance, inadequate access to land and capital, and vulnerability (women), the poor performance of the agriculture sector lies at the heart of the problem. Agriculture accounts for 70 percent of the labour force, 25 percent of the total GDP, 60 percent of export earnings, 75 percent of raw materials for the industrial sector and 45 percent of government revenue. Yields have not improved and, consequently, Kenya remains food-insecure and is increasingly reliant on emergency food supplies and commercial food imports for a significant portion of the country's domestic food requirements. Despite the importance of the agriculture sector, its full potential has not been realized. The sector offers opportunities for economic growth, both in the medium and high- potential, as well as in the Arid and Semi-Arid (ASAL) areas. In particular, the livestock industry offers vast opportunities for economic growth especially in ASAL areas, which have over 50 percent of the livestock. A number of root causes have been suggested for the poor agricultural performance, including misallocation and underinvestment in agriculture, disengagement of Government from support to agriculture, poor infrastructure, limited access to credit, and the high cost of farm inputs. Greater recognition must be given to agriculture as a priority sector in Kenya and SSA as a whole, including the allocation of increased funding in national budgets as recommended by the African ministers of agriculture. Competent and enduring responses must include issues such as community access to land and land tenure, preservation of agricultural diversity, access to credit and agricultural inputs and proper land

**PP241: Analysis of Some Social And Demographic Indicators: Bayesian Spatial
Modelling Approach
(Abstract Id: A5-7-003)**

^aSandeep Mishra, ^bAnoop Chaturvedi
University of Delhi, Delhi, India

^bUniversity Of Allahabad, Prayagraj, India
sandeepstat24@gmail.com, anoopchaturv@gmail.com

When data are collected from points or regions located in space, the observations in close geographical proximity often show dependence. The application of linear regression models for modelling such data often lead to poor forecasts. The spatial autoregressive (SAR) models, which are designed to accommodate such spatial dependence, provide a viable alternative to linear models. The spatial data from various fields such as Ecological data, demographic data, tendency of neighbourhood spread in epidemiology exhibit spatial pattern. Almost all the subfields of agricultural economics exhibit spatial dependence. For instance, the regions in similar agro-ecological zones (AEZ), i.e., homogenous and contiguous areas with similar soil, land and climate characteristics, often tend to impact each other and in developing models one should take into account such spatial dependence for better forecasts. The tools developed for analysing and modelling spatial data are usually extensions of familiar statistical techniques such as regression, generalized linear models, and time series models. This paper considers an empirical application of SAR model and generalized Bayes procedure for three important indicators related to socio and demographic structure of the Indian subcontinent i.e. population under poverty line, infant mortality rate (IMR) and total fertility rate (TFR). This paper also shows that, the generalized Bayes estimators perform better than feasible least squares and Stein Rule estimators in the presence of spatial autocorrelation in the data.

**PP242: An Outlier Detction Technique From A Sample of Johnson Sb Distribution
With Application To Wheat Production Of States Of India
(Abstract Id: A5-7-003)**

Tanuja Sriwastava

An outlying observation, or outlier, is one that appears to deviate markedly from other members of the sample in which it occurs. Although outliers are often considered as an error or noise, they may carry important information. Detected outliers are candidates for aberrant data that may otherwise adversely lead to model misspecification, biased parameter estimation and incorrect results. Sometimes, it has been observed that what seems as an outlier is actually a real-time information existing in the dataset due to some or the other reasons, for example, in the agriculture domain, there is a sudden decrease in the population of Uttar Pradesh, Andhra Pradesh, Madhya Pradesh, and Bihar. The reasons being were not due to any calamity but purely on the fact that these states were geographical divided into subparts. Therefore, if any outlier detection algorithm is fired on that dataset, it may find the new values with sudden decrease as an outlier. The another example is that the sudden increase in production of a crop in a state may occur in the dataset because of the introduction of good high variety of seeds, usage of good quality of fertilizer, and better irrigation facilities, but the same may be treated as an outlier when compared with the past information. In this paper, a test statistic for lower outlier detection has been developed from a sample of Johnson SB distribution when parameters are known. A simulation study is carried out to study the performance of the test statistic. It's application over to Wheat production of states of India is carried out. This paper also shows that the developed test statistic performs good.

PP243: Demand Forecasting of Improved Agricultural Implements in Madhya Pradesh, India using Kalman Filter

(Abstract Id: A1-1-026)

Manoj Kumar, V Bhushana Babu and M B Tamhankar
ICAR-Central Institute of Agricultural Engineering, Bhopal-462 038, India
manoj_iasri@yahoo.com

Shortage of agricultural labour is an important bottleneck in agricultural production system. It is estimated that percentage of agricultural workers of total work force would drop to 25.7 % by 2050. It is necessary to promote farm mechanization for doing agricultural operations at faster rate because there is very small time interval for many agricultural operations and these operations require to be done at appropriate time for getting better yield of the crop. It has been observed that there is a significant increase in production, productivity and farmer's income with the use of improved agricultural implements. The adoption of improved agricultural implements has been increased in recent years. Also, the demand of agricultural implements is highly influenced by the change in cropping pattern. In the present paper, demand forecasting of 45 improved agricultural implements has been done for the Madhy Pradesh state of India using Kalman filter methodology. For this purpose, time series data on the sale of agricultural implements from 2000 to 2017 were collected using cluster sampling from 138 farm machinery manufactures. A decline trend in the demand of bullock drawn implements was observed whereas many tractor drawn implements exhibited increasing trend. The increasing trend in the demand of Maize planter and Cage wheel since last few years showed that the area under soybean is being replaced by Maize and Rice against the traditional soybean-wheat cropping pattern. Also, a decline trend in traditional potato planter and increasing trend in automatic potato planter was observed which showed that traditional potato planter is being replaced by automatic potato planter.