ABSTRACTS
(Thematic Oral Presentations)

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

Sub-Theme T1: Data Analysis/Data Integration

Session T1.1: Sampling Methodology (1)

T1.1.1: A model-assisted approach to identify a cost-efficient spatial sampling strategy (Abstract Id: A1-1-012)

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FAO and UNSD elaborate guidelines to assist countries in planning and implementing agricultural and household surveys. The central topic of these guidelines is the development and maintenance of master sampling frames and they give basically the same recommendations: using dual (area and list) sampling frames and selecting replicated samples. In fact, they focus on area sampling frames because an area frame is complete, accurate and up-to-date. The list frame is a list of outlier holdings sampled at a 100% rate, and used to improve the area estimator precision. In the area frame, the last sampling unit is a segment (a small area, called block in household surveys) and recommending a segment size is difficult, taking into account the large landscape diversity among countries. FAO recommends a target segment size between 10 and 15 holdings and UNSD recommends a block target size of 10 households. We propose a framework to identify the most cost-efficient spatial sampling strategy.

Building and area frame is costly and use up an important part of the available budget. Taken into account the area frame (fixed) cost, we look for optimizing the sample design by finding the segment size, the replicate size and the sample size that minimize the sampling error, subject to the available budget. The sampling error depends on the correlation structure of the survey variable and we use correlogram models to anticipate the sampling variance. The most cost-efficient sampling strategy is the one having minimum sampling variance, subject to the available budget.

T1.1.2: Improving efficiency of the sample design in the Finnish horticultural survey (Abstract Id: A1-1-058)

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The improvement of the sampling designs is increasingly crucial as the varying information needs are adding to the complexity of the surveys, and the statistical offices must balance between the statistical and response burden. Improving the efficiency of the sampling design is directly reducing the survey costs and the response burden. The horticultural statistics are required for the agricultural and environment policy needs based on the European Union regulations on permanent crops and crop statistics and for national data needs. The Finnish horticultural survey has been conducted annually as a total survey with a threshold on standard economic output (SO) of the horticultural enterprises. The standard output of an agricultural product, is defined as the average monetary value of the agricultural output at farm-gate price, in euro per hectare. Traditionally, the threshold has been relatively low in the horticultural survey in comparison to the average wages of the households. Our target is to improve the survey efficiency. The

impact of the small horticultural enterprises for the final survey estimates is studied over time including their impact on the survey costs, and on the quality of the survey data. We investigate with sensitivity analysis the increase of the threshold controlling for the quality and coverage of final estimates as well as on the survey costs and response burden. In the sensitivity analysis, we can detect the optimal threshold on the standard economic output to balance the survey costs and the required quality criteria. We present the method of establishing the standard economic output for the horticultural enterprises in the sampling frame. The horticultural survey uses both the auxiliary data from farm and horticultural registers; and collects directly information about the production of horticultural products and on the use of energy at the horticultural enterprises. The data collection of the horticultural survey is based on mixed-mode approach; using register data, web-survey, telephone interviews and accepts also paper questionnaires. We examine the optimal level of thresholds to validate the achieved quality, the web-survey response rate and surveys cots. It is expected that larger horticultural enterprises tend to respond through the web-survey more likely; while those who are interviewed tend to be on average smaller enterprises. We will also present the impact of the efficient sample design on the expected improvement on the timeliness of the survey data.

T1.1.3: Nonoverlapping samples in agricultural surveys: Issues on cumulating data (Abstract Id: A1-1-023)

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In official statistics a common approach when defining the sample size is considering available funding and the survey objectives. Budget, technical and operational capacity are to be used as efficient as possible to meet demand. Under those conditions, sample allocation became an important issue in sampling. In agricultural surveys, commonly, the sample allocation is defined taking into consideration mainly statistical strata and territorial domains. However, several phenomena of interest are seasonal. In addition to annual activity data, there is also interest for time-related information for forecast and other purposes linked to agricultural policy. To meet such demand depends on a multiple-visit survey. For a given budget, multiple visits to the same producer limits the sample size. Otherwise, visiting any other producer may not allow producing required information. An alternative that arise is the use of nonoverlapping samples. Such approach has been successfully applied to produce population statistics, both in household surveys and censuses. The paper raises issues on the use of the nonoverlapping rolling samples survey and cumulating samples as a way of improving agricultural statistics without raising costs. Pros and cons of single sample and of nonoverlapping rolling samples, as well as rolling samples and cumulated estimates benefits are discussed.

T1.1.4: Optimal sampling for the integrated observation of related populations (Abstract Id: A1-1-018)

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Social or economic studies often need to have a global view of society. For example, in agricultural studies, the characteristics of farms can be linked to the social activities of individuals. Hence, studies of a given phenomenon should be done by considering variables of interest referring to different target populations that are related to each other. In order to get an insight into an underlying phenomenon, the

observations must be carried out in an integrated way, in which the units of a given population have to be observed jointly with related units of the other population. In the agricultural example, this means that a sample of rural households should be selected that have some relationship with the farm sample to be used for the study. There are several ways to select integrated samples. This paper studies the problem of defining an optimal sampling strategy for this situation: the solution proposed minimizes the sampling cost, ensuring a predefined estimation precision for the variables of interest (of either one or both populations) describing the phenomenon. Indirect sampling provides a natural framework for this setting since the units belonging to a population can become carriers of information on another population that is the object of a given survey. The problem is studied for different contexts which characterize the information concerning the links available in the sampling design phase, ranging from situations in which the links among the different units are known in the design phase to a situation in which the available information on links is very poor. An empirical study of agricultural data for a developing country is presented. It shows how controlling the inclusion probabilities at the design phase using the available information (namely the links) is effective, can significantly reduce the errors of the estimates for the indirectly observed population. The need for good models for predicting the unknown variables or the links is also demonstrated.

T1.2: Sampling Methodology (2)

T1.2.1: Accuracy of aggregates built by integration of administrative and survey data (Abstract Id: A1-1-019)

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The Italian National Statistical Institute (Istat) is currently engaged in a modernization programme which includes a significant revision of the methods traditionally used for the production of official statistics, in accordance with European Statistical System commitment to Vision 2020 and UNECE - HLGMOS. The principal concept underlying this important change is the use of the Italian System of integrated statistical registers as a basis for the all the production system of official statistics (ISSR). ISSR has been created by a massive integration of administrative archives and survey data, and called for a big initial investment in architecture, methodology and professional competences, and continues to require ongoing work. Reducing costs, improving timeliness, enhancing consistency and in general the enrichment of the information produced are the expected advantages of the new production model. To produce official statistics on the base of a joint exploitation of different represents a strategic challenge for National Statistical Institutes: it means to move, after 75 years, from the paradigm of statistical inference based on sample surveys to a mixed data source paradigm for the future. In particular, it implies: a renewed role of sample surveys, not only irreplaceable for relevant variables and sub populations, but also crucial for feeding the ISSR and evaluating the quality of new data sources such as big data; new possible approaches to evaluate and communicate the accuracy of the statistical estimates. To build the ISSR, starting from a microdata level, different statistical techniques have been adopted, e.g.: record linkage, statistical matching, projection estimators, other model predictions for single units, Hidden Markov Models, etc.. Many of these techniques, however, result in defining predictions at the unit level. As a consequence, we have an increase in the amount of available information as compared to each source when it is considered individually. On the other hand, the register values are the output of statistical processes subject to statistical uncertainty with respect to both units and variables. The access to the ISSR is mediated by a purposefully designed access layer. Istat is committed to make the system more flexible for the users, allowing different users to produce their own statistics from the ISSR. This pushes the need

to face new methodological and technological challenges: how to ensure the confidentiality of the results? How to measure the accuracy of the register estimates? And how to make the users aware of the accuracy? Istat has chosen to make users informed of the accuracy of the estimates, which is positive for trust, transparency and for a correct use of register data. It represents a coherent goal with respect to the production of the estimates, but it is computationally complex. In the paper we focus on the estimation of a population total which is fundamental to estimate the dimension of a quantitative variable or the level of diffusion of a qualitative variable in a population, as well to estimate its arithmetic mean among the units.

T1.2.2: Sampling in complex scenarios: Finding breathing space for NSOs (Abstract Id: A1-1-015)

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Data collection becomes complex as our quest for information grows. NSOs around the world are being implementing different complex survey methods for their regular surveys. Now a days integrated surveys are being planned in many countries to use the resource and time efficiently. However, greater data demand is evident in the context of SDG monitoring, for which NSOs are yet not ready. On one hand big resources and skilled manpower are necessary, on the other hand limited time is available to feed the data demand. Hence, interim and ad-hoc approaches may be followed. This article will try to find solutions, how available sampling methodologies may be used, to generate data in some complex scenarios. Following three scenarios will be considered. i) When we have two mutually exclusive sampling frames to produce estimate for the entire population. This may happen for example, to ascertain agricultural production for the entire country having a) farm household-based agriculture andb) operational holding owned by GO/NGO/business farms/under contract farming etc. In this case we may have two frames, namely farm household fame and business registrar. ii) When some clusters having units dispersed over the entire land scape. For example, for cost of production surveys, some districts (clusters) may have farmers cultivating a crop spread over the entire cluster, or the number of farmers is very low for planning a fruitful survey. iii) Integrated surve ys planned as sequential sub-samples of previous surveys. For example, a sub-sample of the crop area surveys may be selected for yield survey, another sub-sample from the yield survey may be selected for cost of production survey, and so on drawing sub-samples for crop monitoring and, stock surveys etc. This approach is manageable and cost-effective where NSOs have established field offices. The current article will discuss possible ways to plan survey sampling and finding estimates with possible ways for variance estimation for the desired estimates. Crop survey is a regular survey of each of the NSOs, hence, efficient ways of capturing data would help them generate data regularly with greater precision. Planning too many surveys sometimes go beyond the scope of the NSOs. This will also ease the burden of data demand for SDG monitoring in various sectors.

T1.2.3: Modified sampling methodology for estimation of area and production of horticultural crops (Abstract Id: A1-1-046)

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The estimates of area and production of important fruits and vegetables were obtained in India under the scheme on Crop Estimation Survey on Fruits and Vegetables till 2012-13 using the methodology earlier developed by Indian Agricultural Statistics Research Institute (IASRI). In view of National Statistical

Commission (NSC) recommendation, a project entitled "Pilot study to develop an alternative methodology for estimation of area and production of horticultural crops" funded by Central Statistics Office (CSO), Ministry of Statistics and Programme Implementation, Govt. of India was undertaken by IASRI. One important recommendation of this study was to validate and test the developed methodology before its implementation at large scale. In view of the above recommendation, a project funded by Department of Agriculture, Cooperation & Farmers Welfare (DACFW), Ministry of Agriculture & Farmers Welfare (MoAFW), Govt. of India was undertaken by IASRI. Under this study, a modified sampling methodology for estimation of area and production of horticultural crops has been developed. The sampling design proposed for the survey was stratified multistage random sampling. The prposed sampling design was an integrated sampling design for both fruits and vegetables survey. Estimation procedures to obtain district level estimates of total production, yield rates and area under important fruits as well as vegetables and number of bearing trees of important fruits were developed as per the proposed sampling design. Field testing of the developed methodology was carried out in six states namely, Maharashtra, Andhra Pradesh, Tamil Nadu, Himachal Pradesh, Madhya Pradesh and Haryana in 2016-17.

Data analysis was carried out using the data analysis software developed under this study and estimates of area, production and yield for fruits and vegetables for the surveyed districts under study were obtained. The modified alternative sampling methodology provides reliable estimates of area and production of major fruits and vegetables under study. The generated estimates of area and production of fruits and vegetables were compared with the area and production figures published by DACFW. The percentage Coefficient of Variation (%CV) of the estimates were obtained for fruits and vegetables at district level which were acceptable. It is worth mentioning that based on the present study the recommended sample size i.e. number of villages to be selected from a district is 80. Hence, there is a significant decrease in sample size i.e. from 150-200 villages per district (as per CES F&V) to 80 villages per district. The survey procedures under the alternative sampling methodology have been simplified. These are cost effective and less time consuming. The alternative sampling methodology provides estimates for more than one fruit/vegetable at district level. The developed methodology is simple and easy to implement both for fruits and vegetables. The study has revealed very encouraging results and demonstrated the feasibility of estimating the production of fruits and vegetables with much smaller sample size. In view of above, it is recommended that the methodology may be implemented at large scale i.e. in all the states of the country.

T1.2.4: Redefining poverty line (Abstract Id: A1-1-072)

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Reduction of Poverty has always remained a basic objective of Indian Planning. The poverty issue has also featured in Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs). India has achieved Millennium Development Goal (MDG) of reducing poverty by half from the level of 47.8% in 1990 to 21.9% in 2011–12. Even after the claim of achievement, the very definition of Poverty Line has raised a debate as the norm of Rs. 26 per capita per day in rural and Rs. 32 in urban is seen to be too low to be acceptable. The report by Rangarajan Committee which revised upward the Poverty Line to Rs. 32 for rural and Rs. 47 for urban, this raise is viewed as marginal. Now, NITI Aayog has the mandate to develop a working definition of poverty line and to prepare a road map for the elimination of poverty. In view of this, it is important to have a re- look into the measurement of poverty in a holistic perspective. Relating poverty to single criteria of calorie norm has been questioned as this is only one of the ingredients of minimum needs. A definition of poverty line should involve a multi-faceted approach. Ideally, poverty line should make allowances for all basic needs relating to food, clothing, housing,

health, education, travel etc. This presentation will cover the genesis of current methodology and will highlight the issues requiring attention in redefining poverty line.

T1.3: Yield and Production Forecasting and Measurement

T1.3.1: Agricultural statistics production – The case of Zimbabwe (Abstract Id: A2-2-031)

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This Abstract provides contextual information on the organization of the agricultural and crop production forecasting systems in the country. The first part is on the agricultural sector in Zimbabwe, covering the country's geographic context, agriculture ecological zones, land use sectors and legal framework applicable to agriculture. The country has an agriculture ecological gradient comprising of five zones that are distinguished by significant differences in natural physical conditions, including weather parameters and soil types. The land use sectors are categorized by the type of farming practiced. The second part provides information on the country's agriculture statistical system. It provides details on the agricultural sector's statistical system and the national crop production forecasting systems. The reasons for undertaking crop production forecasting and a SWOT analysis of agriculture statistics systems are also presented. The third part focuses on the agricultural crop production forecasting statistics produced by various institutions in the country. The fourth and fifth parts are on information dissemination and recommendations, respectively. Zimbabwe is situated in the southern part of Africa. The country is landlocked and has a total land area is of approximately 390,757 km2. Zimbabwe is divided into ten administrative provinces: The country's main topographical features include: The central watershed/plateau, running from the southwest to the northeast and ranging from 1,200 to 1,500 m above mean sea level. The plateau is 650 km long and 80 km wide.

The mountains along the eastern border with Mozambique, where peaks are around 2,300 m to 2,500 m; and The Zambezi and Limpopo River Valleys to the northwest and southeast, respectively, with an altitude below 500 m. Zimbabwe has five agroecological regions, known as natural regions. They are classified on several factors, including the basis of the rainfall regime, soil quality and vegetation. Agriculture in Zimbabwe is distinguished by the existence of six major land use subsectors: Communal Lands, Old Resettlement Schemes, Small-Scale Commercial Farms (SSCFs), Large-Scale Commercial Farms (LSCFs), A1 Farms and A2 Farms. Both A1 and A2 Farms are a result of the accelerated land reform programme undertaken in the year 2000. These subsectors are determined by agroecological factors, tenure systems, farm sizes, crop and livestock production systems, levels of technology use, management and income levels. In general, communal and smallholder farmers occupy areas of lower natural potential for agriculture, in terms of rainfall, soils and water for irrigation. In all six sectors, agricultural production is for both own consumption and commerce. The Government of Zimbabwe inherited a grossly imbalanced land ownership system, which was heavily skewed towards the white minority race, from the colonial period. The Government found it imperative to redress the imbalances in land resources ownership to reduce poverty and promote sustainable economic growth (NRB, 2002). Proponents of the land resettlement programmes called for an expansion of the resettlement programme to help redress the unequal distribution of land resources and to rectify acute land scarcity, particularly in the communal areas, where the majority of the people resided. The opponents of the land resettlement programmes emphasized the efficiency of the commercial farming sector and the

adverse consequences that a substantially expanded resettlement programme would have on agriculture productivity (Moyo, 2002). The debate on the impact of the land reform programmes scaled up with the 2000 Fast Track Land Reform programme and drew great controversy, both nationally and from the international community. With the Fast Track Land Reform programme of 2000, farms were compulsorily acquired in large-scale commercial farming areas, and farmers from communal and urban areas were resettled into two accelerated resettlement models, namely A1 and A2 Farms. In the A1 Farms model, an individual family farm is allocated six hectares plus a common grazing land for livestock. The A2 Farms are the commercial model of the accelerated land reform programme; in these models, farmers are resettled in such a way that an individual holds a farm within which crops and livestock are produced. The accelerated resettlement models maintain the boundaries of the former LSCF, whilst the Old Resettlement Schemes were composed of a number of the former LSCFs (CSO, 2004). Zimbabwe has three land tenure systems: Freehold/title deeds – deed of grant; deed of transfer; • Leasehold/leases – general lease; Agricultural Land Settlement Act; trading lease; 99-year lease (for the A2 model); Permissory/permits – A1 permit; old resettlement scheme; communal permit; temporary trading permit; 3-tier settlement.

T1.3.2: SatAgrarStat – Assessing a method of crop yield estimation incorporating remote sensing (Abstract Id: A1-1-067)

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The presentation will inform about a joint research project of the Federal Statistical Office and four German statistical offices of the Länder Hesse, Lower Saxony, Bavaria, Schleswig-Holstein together with the Julius Kühn-Institut, which is the Federal Research Centre for Cultivated Plants. The project is testing an approach to estimate harvest yields of winter wheat, winter rape and spring barley based on Sentinel-2 satellite images. It started in early 2018 and runs until the end of 2019. The current German system of ascertaining average yields per hectare and harvested quantities consists of a combined sampling and survey method. The harvested quantities are calculated by multiplying the areas under cultivation as collected from the producers (main survey of agricultural land use) by the yields per hectare as ascertained in the crop production reports and the Special Harvest and Quality Survey. For vegetables and some fruits a combined production area and yield estimation survey is used. The crop production reports provide yields per hectare and yield forecasts for several field crops and grassland, fruits, wine and vegetables. For the particularly important crops of cereals, potatoes, and winter rape, the crop production reports are supplemented by the sampling of Special Harvest and Quality Survey method. On fields selected at random, average crop yields and other variables determining the yield are ascertained for the most frequent cereals (e.g. winter wheat, rye, winter barley, spring barley and triticale), potatoes and winter rape. For the purpose of the SatAgrarStat project, a crop yield model was developed which is using remote sensing data and in situ-data of vegetation parameters, land cover and harvest yields. Partially these data are supplied by farmers who voluntary participate in an additional survey on four dates per year. The project survey of 2018 is completed. The 2019 survey is on the way. First harvest yield estimations from 2018 for the above mentioned crop types are available. The results will be compared to the results of the official harvest yield statistics. Ideally, the approach could complement or substitute official harvest yield statistics in the future with the intention to reduce the number of reporting units and so burden on respondents. The presentation will finally show results, prosperity, challenges and perspective of the project.

T1.3.3: Challenges and opportunities in agriculture crop statistics - Case of India (Abstract Id: A1-1-029)

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To ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, we need to have an accurate and reliable crop estimation system. This can be approached using the modern tools such as remote sensing, artificial intelligence, etc. to provide a close to real-time system for better monitoring the situation and better design of policies. Currently, Improvement of Agricultural Statistics Scheme is being implemented in 26 States in order to ensure reliability of data received in the form of area, production and yield estimates. This is achieved through area enumeration and conduct of Crop Cutting Experiments which derives the estimates of yield of crop on parcel of land through scientific methods. The challenges in deriving these estimates include various non-sampling errors which affects the efficiency. It could be tackled through various modern technologies such as Geographic Information System (GIS), Remote Sensing Technology (RST), Machine Learning (ML) Models, etc.

T1.3.4: Modeling based approach for estimating and forecasting crop statistics (Abstract Id: A1-1-031)

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India Meteorological Department jointly with Agro-Met Field Units (AMFUs) and other agencies have developed series of agromet models using statistical and crop simulation approach to generate crop production forecast of targeted crops under Forecasting Agricultural output using Space, Agro-meteorology and Land based observations (FASAL) and Coordinated Horticulture Assessment using Management using geoiNformatics (CHAMAN) schemes. Though spatial observation on weather and planting time (and management practices for rainfed situation) allows broadly to assess crop condition in the field, recent improvement in skill of extended / seasonal climate forecast at Meteorlogical Sub-division level in India made it possible to make an early and in-season crop production forecasting with satisfactory skill at state and national level. Accurate forecasting of extreme weather events helps to estimate loss / damage of crop over a region and make adjustment to production figure of agriculture commodity. Such estimates are necessary to improve the crop statistics and guide the agricultural sector for sound planning and policy making in the country.

T1.3.5: Use of Double Technique Based Domain Estimation Approach for Estimating Crop Area and Yield Under Mixed Cropping (Abstract Id: A1-1-006)

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Farmers, across globe, practice mixed/intercropping to spread risks. Currently, single variable models involving objective/subjective variables are used in various countries for estimation of crop area and

yield. However, large sample sizes are needed to generate estimators of crop area/yield under mixed cropping due to heterogeneity in the data. To reduce the sample size, on the objective variable (expensive to sample) used for measurement of crop area and crop yield, the domain estimation theory based double sampling regression estimator was proposed by suitably combining the objective variable and relevant auxiliary variable (inexpensive to sample).The domains comprised crops grown in mixtures and in pure stand. The domain estimators were suitably combined to obtain estimators of crop area/yield. Accordingly, a stratified two-stage sampling design with two phases at each stage of sampling was proposed for the selection of sample. The Sub-districts within a district were considered as strata. Within a stratum sample of villages/Enumeration Areas (PSUs) were selected and in each selected PSU a sample of households/parcels/segments (SSUs) growing the selected crop were selected and data collected on auxiliary variables related to crop area like farmer assessment of crop area, family size, number of active members of family, seed rate etc. A sub-sample of already selected PSUs and SSUs was selected for data collection by GPS (objective variable). Estimators of crop area were framed using the double sampling regression estimator by using an auxiliary variable having maximum correlation with the objective variable. The sample selected for crop area estimation provided the sampling frame for sample selection for crop yield estimation. The same design ,as in case of crop area estimation, was adopted for crop yield estimation wherein farmers' estimate of crop produce and farmer recall of crop produce were taken as auxiliary variables while crop cutting experiment, sampling of harvest unit, whole field harvest techniques were considered as main variables. Several double sampling technique based regression estimators were developed using one auxiliary and one objective variable- the one which provided least percentage standard error was recommended for crop yield estimation in each of the selected countries. The developed methodology was tested in one/two districts each in Indonesia, Rwanda and Jamaica. The results revealed that, for the same level of precision, the reduction in cost by using regression estimator over an estimator which use only the data on objective variables like GPS for area estimation while , in each of three countries ,either, crop cutting experiment, whole field harvest and sampling of harvest unit methods for crop yield estimation was substantial under a suitable cost function thereby highlighting the need to use two variable model for estimation of crop area and yield under mixed cropping as opposed to the single variable model. It is pertinent to note that higher the correlation between objective and auxiliary variable and cheaper the cost of data collection on auxiliary variable vis-a-vis the objective variable, greater the reduction in cost in using the regression estimator. A simplified version of the proposed methodology has been discussed for ease of implementation.

Session T1.4: Innovation in Agricultural and Household Surveys

T1.4.1: Comparative analysis of the self-reported, GPS-based, digital map based, and paper-based area measurements at the plot level (Abstract Id: A1-1-034)

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The agricultural sector is of vital importance for the economy of Ecuador due to its contribution in the Gross Domestic Product (GDP) that according to figures from the Central Bank of Ecuador (ECB), in the last decade it has been 8%, being the most contributes after Manufacturing, Oil and Mining, Construction, Trade and Education of Social and Health Services. In addition, it plays a strategic role within the global concept of food security, since it provides most of the food for the population. Ecuador has developed a system of continuous agricultural statistical information from 2002 to the present that is based on a probabilistic survey that captures the data directly from the producer applying the methodology of multiple sampling frames. Being the producer who reports the information, there is a risk of introducing

measurement bias (by response) in the estimations since the informant in many cases does not accurately report the area of their land with its uses. For this reason, since 2014, ESPAC has applied two methods to collect the area of the plots: (i) declared area for the respondent and (ii) area measured in the cabinet through orthophoto delineated in field; this first exercise made it possible to identify measurement biases on the surface. For 2018, the ESPAC-AGRIS pilot incorporated additional measurement methods for the area, one of them was editing the orthophoto's terrain of the selected segment using the Survey Solutions application and also making an objective measurement of the terrain using GPS. This allows us to perform a comparative analysis of the measurement bias by the 4 methods applied in the pilot at the field level and identify the possible impacts on the estimates. In addition, the applicability and implications of using Survey Solutions for the measurement of digital area in the field is evaluated. This paper contributes to a better understanding of the impact of the response bias in the final estimates as well as to improve the improvement and continuous optimization approach for the procedures of generating statistical information.

T1.4.2: Getting the (gender-disaggregated) lay of the land: The impact of survey respondent selection on measuring land ownership and rights (Abstract Id: A1-1-035)

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As more African countries are recognizing the need for land reform and strengthened land information systems for recognition and governance of formalized land rights, gender relations constitute a non-ignorable dimension of the process. With weak land information systems, limited avenues for objective identity verification and complex intra-household bargaining dynamics, even the presence of a legal document does not always guarantee the proper recognition of one's ownership claim. To properly measure advances in securing and protecting land rights from a gender perspective, several dimensions of ownership, bundle of rights and their inter-relationships must be monitored at the individual level. While collecting detailed individual-disaggregated information as part of household surveys on these topics may help accomplish this objective, the analytical implications of the approach to respondent selection are not fully known by survey practitioners and analysts. This paper contributes to a body of work on the relative empirical and cost implications of different approaches to respondent selection in the context of household surveys focused on individual level asset ownership and control. Following recommendations from a randomized household survey experiment implemented in Uganda, one component of the Integrated Household Survey in Malawi in 2016/17, administered individual interviews covering several key assets, and ownership and rights constructs, and identified, at the asset level, individuals associated with each of these phenomena. The questionnaire probed directly and solely regarding respondents' personal ownership of and rights to assets. Compared to interviewing multiple individuals within households, we find that only interviewing the "most knowledgeable" household member leads to under-reporting of ownership by women. As a result, surveying multiple individuals within the household closes gender gaps in reporting of asset ownership. We also find substantial agreement over land ownership among couples in the individual-interviews approach — and when there are discrepancies, indicators of greater household status for women are positively associated with discrepancy scenarios where the woman attributes at least some landholding status to herself.

T1.4.3: Integrating social, biophysical and earth observations data to improve understanding of factors contributing to crop yield in Mali, with further application to agricultural statistical infrastructure and estimation of agricultural production in non-permissive environments
(Abstract Id: A1-1-045)

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Understanding the factors that contribute to crop yields is critical for designing programs to help farmers improve their production, and for improving forecasts of yields as part of a food security early warning system. These factors include plot management practices, agricultural inputs, soil characteristics, and temperature and rainfall. However, it is uncommon to find in one integrated dataset all of the variables required to perform this kind of analysis. This paper presents preliminary results of an analysis of the factors contributing to crop yields for maize, millet and okra using a unique dataset, the 2019 Feed the Future Zone of Influence Survey in Mali. This population-based household survey collected data on farmers' plot management practices and input use for maize, millet, and okra via a CSPro data entry program administered on Android tablets. Farmers' plots were walked using a tablet-based land area measurement application that calculated field area and saved plot perimeters as georeferenced polygons. Soil characteristics were assessed and recorded using a tablet-based application (LandPKS) designed by the US Department of Agriculture to characterize the potential of the land to sustainably generate ecosystem services required for optimal crop production. Remotely- sensed variables including those related to rainfall and temperature are linked geospatially to the plots. The Feed the Future Zone of Influence Survey's primary objective was measuring Feed the Future's key performance indicators. However, the integrated design of the survey allows us to leverage new technologies and data to further explore the factors contributing to crop production in Mali. These data can also be used as inputs into development of additional innovations for agricultural statistics. One example would be using the plot perimeter data to feed machine learning algorithms to produce a comprehensive field boundary database product, something that would constitute a critical piece of informational infrastructure, particularly for Ministries of Agriculture. Another would be linking Earth observations data captured over the Mali plot polygons to the results of our yield analysis to help us estimate production in non-permissive environments in Mali and beyond. These data can also contribute to reporting on SDG indicator 2.4.1, percentage of agricultural area under productive and sustainable agriculture.

T1.4.4: Land measurement bias: Comparisons from global positioning system, self-reports, and satellite Data (Abstract Id: A1-1-033)

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Despite the centrality of land as a constraint to poor households emerging from poverty, self-reported land area, which suffers from significant measurement errors, continues to be the prevalent method of collecting this data in agricultural surveys. The compass-and-rope method, a second option wherein two or three enumerators measure the area of a plot using tools such as calculator, compass, measuring tape, and ranging poles, is considered the gold standard for land area measurement but is workload-intensive and expensive. Global Positioning System (GPS) devices have more recently been used in agricultural surveys but still require walking along the boundary of a plot to obtain an area estimate, thereby increasing survey time and costs. Improved survey methods and technological capacity in the field and remote sensing data are opening new possibilities for agricultural statistics. This paper contributes to the land measurement literature by presenting the results of a validation study that compares estimates of plot size from farmer self-reports, GPS-measurement, with plot area measurement using a combination of Google Earth images and digitization techniques. We then look at how measurement error in land size affects the relationship between agricultural productivity (measured in terms of yield) and plot size. Finally, we provide evidence on cost savings with using Google Earth relative to GPS based area measurement. The validation study was conducted in four pilot provinces of four Asian countries: the Lao People's Democratic Republic (Lao PDR), the Philippines, Thailand, and Viet Nam. We find that the magnitude of self-reporting bias is nonlinear and varies across countries, with the largest magnitude of self-reporting bias of 130% of a standard deviation (2.2-hectare bias) in the Lao PDR relative to Viet Nam, which exhibits 13.3% of a standard deviation (.008-hectare bias). In all countries except Viet Nam, the inverse land size–productivity relationship is upwardly biased by lower land area self-reported measures relative to GPS measures. We also find that on average, there are no significant differences between remotely sensed data and GPS measures taken by field teams. Given the lower cost of publicly available remotely sensed data relative to GPS data, linking household surveys to these data sources does not induce additional measurement error, particularly for field crops and irrigated areas where plot boundaries are spatially distinguished. Our results are important within the context of Target 2.3 of the Sustainable Development Goals (SDGs) which aims to "double the agricultural productivity and incomes of small-scale food producers" by 2030. Small-scale food producers are defined using two criteria – (i) physical size of the farm and (ii) the economic size of the farm. The results of our study imply that both criteria may be subject to significant measurement errors in countries with weak statistical systems and imprecise land records. This calls for strategic investments in digitized agricultural cadastral maps in developing countries using novel techniques such as remote sensing.

Session T1.5: Data integration: a Way of Improving Agricultural Statistics

T1.5.1: Examining ICT-led growth using South Africa's public-private data set: An industry-level analysis (Abstract Id: A1-1-042)

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South Africa is faced with severe economic challenges such as sluggish growth and high unemployment rate. Yet, investment in information and communication technology (ICT) has been proven to boost productivity and resuscitate growth in other countries. Specifically, the resurgence in productivity performance and growth in the US and other OECD countries in the 1990s has been attributed to both the expansion in the production of ICT and use by other economic sectors. It is on this premise that the UN's Sustainable Development Goal 9 views increasing access to ICT and supporting innovation and technology development as some of the strategies to enhance productivity and development in developing countries. Despite these, empirical findings have been less supportive, tending to unravel negative or even zero significant effects of ICT for developing countries but positive effects for the developed countries. The negative or insignificant findings for the developing countries are attributable to numerous factors, including the lack of high-quality data and the quality of the analytical approaches used. To address these challenges, this paper examines ICT-led growth using South Africa's public-private data set. The aim of the paper is, therefore, to estimate the effects of ICT intensity on labour productivity, employment and output of agro-processing industries for the period 1994 to 2017. Data for calculating the ICT intensity were sourced from the Statistics South Africa's input-output (I-O) tables (i.e. public data). However, Statistics South Africa only began to publish the I-O data on an annual basis from 2009 to 2014, with 2014 being the latest year of publication. Given this, I-O data from the South African Standardised Industry Indicator Database (SASIID), which is collected, managed and owned by Quantec, is used for the missing years (i.e. private data). Further to this, data on productivity, employment and output were also sourced from the Trend Tables of the SASIID due to lack of comprehensive and up- to-date data from the Statistics South Africa. Thus, this paper contributes to the overarching need for improved agricultural data by integrating both the public and private data sets. It further contributes to the literature by highlighting how developing countries such as South Africa can experience ICT-led gains from ICT investment using integrated data set.

T1.5.2: From collection to integration: Applying statistical matching to primary and secondary farm data (Abstract Id: A1-1-022)

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The evaluation of the agricultural policies is based on the assessment of their impact(s), efficiency and effectiveness. One main practical issue that limits this assessment is represented by data shortage in terms of both data availability and accessibility. Indeed, secondary data collections (e.g. the classic massive national censuses) are being progressively limited due to costs-reduction rationale while their accessibility is often restrained due to the strict privacy claim constraints. On the other hand, primary data can be really expensive to collect ex novo each time, imposing also relevant time needs. However, despite these drawbacks, two main advantages are offered by secondary and primary data sources, respectively. The former sources offer a

comprehensive and exhaustive information while the latter data usually can be more timely and more deeply focused on the topic of interest. Within this scenario and considering the aforementioned potentialities and drawbacks, the possibility to plan and execute alternative "data collections" by means of data integration methods acquires greater significance. Among the researchers and the Official Statistics there is a widespread debate related to the possibility of increasing the quality of data and their availability by integrating different already collected data, e.g. several administrative registers, official statistics and ad hoc project surveys. One of the most up-to-date method that can be applied for these purposes is Statistical Matching (SM), commonly divided between the parametric approach and the non-parametric one. This latter, or the so- called hot deck methods, allow to integrate data without any assumption on the variables' family distribution (hence by avoiding the potential integration bias) as well as by resorting only to the "live" observed information. Nevertheless, some methodological challenges are still opened with respect to the non-parametric SM approach, the most relevant one being related to the validation of the performed integration. We apply such a method within different integration exercises with real primary and secondary data sources (ad hoc project surveys and the Farm Accountancy Data Network data source of the European Union), proposing a new validation strategy for the assessment of the integration goodness. We discuss the potentialities of such a method analyzing its potentialities, its still opened features as well as its limitations.

T1.5.3: Agricultural data integration using spatial subgroups analysis (Abstract Id: A1-1-025)

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In agricultural statistics, one often need to integrate data from multiple sources to improve the coverage and quality of the data. In this paper, we develop a new unit level spatial model based on a pairwise penalized regression approach to integrate remote sensing data with ground observations. Instead of assuming common regression coefficients for all small domains in the traditional model, the new estimator is based on a subgroup regression model which allows different regression coefficients in different groups. The alternating direction method of multipliers (ADMM) algorithm is used to determine the subgroups with different regression coefficients, and pairwise spatial weights are introduced for spatial areal data. The methodology is applied to integrate the satellite remote sensing data from Landsat and data from National Resources Inventory survey in Iowa.

T1.5.4: Using registers to update a census-based sampling frame: (not exclusively) Brazilian challenges (Abstract Id: A1-1-024)

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To improve agricultural statistics, in order to meet accordingly growing national and international demands for more and better statistics, the Brazilian Institute of Geography and Statistics - IBGE is promoting reformulation of the national agricultural surveys system. The new system will be based on Census, Surveys and Registers. An important component of the tripod system is a probabilistic survey, compatible with the Agricultural Integrated Survey – AGRISurvey, that will be implemented early next decade. As part of preparation for the novelty, a sampling frame based on last census of agriculture is on its way. Census data collection started in 2017 and was finalized in 2018, consequently data reference date includes both years,

therefore data is pretty well up to date. However, as time passes, it will lose correspondence to reality. To find ways for keeping the sampling frame up to date, IBGE has started a series of studies. Considered strategies are primarily data integration to combine administrative data from registers managed by IBGE and other Government sources and complementary face-to-face and telephone interviews. The paper will include consideration on both strategies and show results of experiments using unique ID, coordinates, name and address to identify records in distinct sources that refers to the same producer, therefore can be used to update information already in the frame; and records referring to new producers which can be added to the frame. Aspects on availability of administrative data sources, access to data, record linkage methods and complementary interviews will be approached. In addition, results of an empirical study using registers from disease control, referring to two Brazilian States, will be shown to illustrate the potential of the register to update the census-based sampling frame.

T1.5.5: Data integration in Dutch farm level data collection: use of administrative and commercial sources (Abstract Id: A1-1-027)

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As part of the statutory tasks on behalf of the Dutch Government, Wageningen Economic Research collects financial- economic data and an increasing amount of sustainability data on agriculture, horticulture, fisheries and forestry. This data is supplied to the European Commission (DG-AGRI, DG-MARE and Eurostat) for monitoring and policy evaluation purposes. The data is also used by other users for their statutory tasks (i.e Statistics Netherland, Environmental Assessment Agency and the National Institute for Public Health and the Environment). During the last decade, the reduction of the administrative burden and the increase of efficiency of data collection have become important objectives of the Dutch government. To respond to this objective, Wageningen Economic Research has adopted a strategy of data integration and re-use of existing (electronic) data flows in the agricultural sector. OBJECTIVE - In this paper the strategy of data integration to use administrative and commercial sources for the compilation of farm level statistics will be described. The practical difficulties such as record linking, definition of observation units and access to data together with the developed solutions in the Dutch approach will be described. The impact of this strategy on the costs of data collection, the administrative burden of farmers, the quality of the data and the new opportunities for monitoring and policy evaluation will be evaluated. RESULTS - The use of data from administrative systems (i.e. subsidy payments, land parcels, manure transports, animal numbers) and from commercial systems (i.e. electronic invoices from a central electronic data interchange system, financial transactions from banks, data from auctions, use of antibiotics from a veterinarian system) have resulted in an increased efficiency of data collection. In most cases the quality of the data has increased due to a reduced dependence on farmer recollection and due to the quality mechanisms as applied in the underlying data processes. The administrative burden of farmers has decreased substantially. For many information items the farmer is not asked anymore to provide the data, but only to authorise access to the data from existing sources. Also the opportunities for data use been widened. Collecting sustainability data requires for example the recording of the relevant physical/ material flows at farm level. Often the same source can be used as for financial economic information. If a farmer buys pesticides, fertilisers, petrol etc., the invoice gives the financial amounts. The same invoice gives information on the physical flows, such as quantity and product name of pesticides, quantity and N, P and K content of fertilisers, quantity and type of energy source etc. This facilitates the shift to environmental accounting, which has proven to be a successful approach to provide reliable statistics on the environmental impacts of farms. DISCUSSION - Data integration and the efficiency of data collection can be further improved if all partners of the farmer in the food chain would supplement or replace invoices on paper by digital versions in a standardised format such as xml. Costs of management, financial accounting and statistics would drop substantially.

Session T1.6: Small Area Estimation: Relevant Cost-Effective Method for Producing Disaggregated Data for SDG Monitoring

T1.6.1: Disaggregate level estimation of food insecurity incidence for the state of Uttar Pradesh in India by combining survey and census data (Abstract Id: A1-1-037)

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The empirical plug-in predictor under an area level version of the generalized linear mixed model is extensively used in small area estimation (SAE) for counts. However, this approach does not use the sampling weights or clustering information that are essential for valid inference given the informative samples produced by modern complex survey designs. We consider a small area estimation method that incorporates this sampling information when estimating small area proportions or counts under an area level version of the generalized linear mixed model. We further explore the impact of accessible georeferenced data in this method of small area estimation. This method of small area estimation is then applied to estimate the extent of food insecure household (i.e. incidence of food insecurity) in different districts of the rural part of the state of Uttar Pradesh in India by linking data from the 2011-12 Household Consumer Expenditure Survey collected by the National Sample Survey Office of India, and the 2011 Indian Population Census. A map showing incidence of food insecurity for State of Uttar Pradesh is also produced which provides an important information for analysis of spatial distribution of food insecurity in the state. These disaggregate estimates are useful and relevant to sustainable development goal indicator 2.1.2 - severity of food insecurity. The estimates and map of food insecurity incidence are expected to provide invaluable information to policy-analysts and decision-makers.

T1.6.2: Implementation of SAE to produce district level agricultural statistics in developing countries: Lessons learned from the Tanzania' s experience (Abstract Id: A1-1-050)

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In the framework of Global strategy initiative, a specific project aimed at implementing fully the Small Area Estimate (SAE) methodology in a pilot country to produce agricultural data at low geographic level has been promote by FAO and meet the interest of Tanzanian authorities. In the case of Tanzania, the need of the Government and local authorities was dispose of disaggregated data at District level for local policies formulation and monitoring. The project, funded by FAO and Irish cooperation put emphasis on sustainability and ownership of the results with a strong component of capacity building. The project worked at designing the suited model according to the available data at district level like 2012 population census data, 2007 agricultural census data, administrative routine data and land use and geographical data, combined with the annual agricultural sample survey data at regional level to generate district level data relevant local policies but also for SDG monitoring. This paper aimed at presenting a best practice (the case of Tanzania) notably the aspects considered as successes regarding the way the project activities

have been conceived, planned and implemented, the results obtained, the process of data validation and the ownership of the project results by nationals. The aspects also considered as weaknesses will be discussed including how to replicate successfully in other countries with similar conditions.

T1.6.3: Issues in the integration of survey and administrative data on agriculture: A case study of Namibia (Abstract Id: A1-1-060)

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Survey, census, and administrative data provide important information for official statistics on agriculture. Different data sources can produce conflicting estimates for a variety of reasons, including differences in definitions, reference periods, and data collection methods. Such differences create challenges for statistical agencies when combining disparate data sources to produce a single estimate. Despite challenges, integrating statistical data with administrative data is appealing because of the potential to save on data collection costs, reduce respondent burden, and improve the coherence of estimates produced by different offices. As part of the Food and Agriculture Organization (FAO) Global Strategy research project on using administrative data for statistics in developing countries, we conducted a pilot study on integration of administrative and survey data in Namibia. In this talk, we discuss issues associated with integrating statistical and administrative data in the context of agricultural statistics for Namibia. We review the properties of the 2013/2014 Namibia Agricultural Census as well as administrative data collected by the Namibia Ministry of Agriculture, Water, and Forestry. Using this data, we illustrate small area estimation as a technique to combine estimates from different sources.

T1.6.4: Small area models for poverty and unemployment rates in Thailand (Abstract Id: A1-1-062)

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Poverty and unemployment are two major issues in many countries around the world including Thailand. The increases of the two rates had affected the economic growth of the country. Therefore, the Thai government has included the goal of reducing such rates as the two main sustainable development goals for Thailand. However, to have an effective plan, a precise prediction of such rates is needed. In this study, we propose a small area model and a data linkage method to forecast and find relationships between the poverty rates and unemployment rates in Thailand. The data sets used in this study are the household expenditure record, the Household Socio-economic Survey, and the labor force data, the Thailand's labor force surveys (LFS), conducted by the Thailand's National Statistical Office (NSO).

Session T1.7: Spatial Sampling Designs and Spatial Data Analysis

T1.7.1: Distance balanced sampling plans useful for sampling from naturally ordered populations (Abstract Id: A1-1-028)

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Consider estimation of population mean of a variable under study from a finite population through survey sampling. Assume that the population units have some natural ordering and as a result, it is expected that observations from adjacent units are similar in nature. Some examples of estimation problems from such populations are estimation of toxicity level at a toxic waste dump site, estimation of damage done to crops by pests in a field, estimation of potato production in a field etc. While designing a sampling plan for such a population, it is desirable that nearby units are avoided in a sample and units from farther distance are given greater probabilities of selection. Based on this concept, a sampling plan called distance balanced sampling plan (DBSP) has been introduced in literature. DBSPs are those sampling plans in which first order inclusion probabilities are constant and second order inclusion probabilities are non- decreasing function of distance such that any two pairs of units at same distance have the same second order inclusion probabilities. Some results on existence and construction of distance balanced sampling plans will be discussed in this talk. The efficiency of these plans with respect to other alternative plans will be illustrated with the help of an example.

T1.7.2: GIS based spatial sampling designs for regular and irregular spatial units (Abstract Id: A1-1-056)

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The units incase of spatial data are tied together like bunches of grapes, not separate like balls in an urn which implies spatial dependency. The neighboring sampling units tend to be homogeneous, when the parameter of interest is spatial in nature. Once a particular unit is selected in the sample, the neighboring units are not likely to provide much additional information of the target population. Earlier, usual traditional sampling designs like Simple Random Sampling (SRS), Stratified Sampling and Systematic Sampling were applied for sampling of spatial data which fails to provide efficient estimators. Therefore, the need to modify the classical approach of spatial sampling technique for spatial data was felt. However, the geographical data is not only dependent in nature but is also highly irregular. It is obvious that a village or district is not a perfect square or a rectangle. This additional problem of irregularity along with dependency makes the study of such data even more difficult. The geographical observations poses their own dimension and are connected to one another in unequally spaced interval. Further in space, there does not exist the complete ordering of observations as a result of which the origin and the direction of a relationship is not given. In this study, a GIS based spatial sampling technique known as Contiguous Unit Based Spatial Sampling (CUBSS) based on contiguous neighbours is developed for regular area units and Distance Unit Based Spatial Sampling (DUBSS) based on distance based neighbours for irregular area units. The technique incorporates size measure along with spatial contiguity of the units in the population. The spatial correlation is estimated for auxiliary character which is used along with size measure in assigning weights for selection of the sampling units. The probability of selection of any unit is governed

by these weights. The principle of sample selection is that the probability of selection of any unit increases as the distance from the units (area) already selected increases. The sample selection criteria is based on the weights accounting for spatial variability and the size measure accounting for areal extent. Further a suitable unbiased estimator which takes into account the order of the draw is suggested for this situation. The study is carried for regular lattice i.e. assuming the area to consist of regular units. A simulation study is then conducted to study the results of the proposed estimators and to compare them with the traditional estimators. The study character for simulation was irrigated area for the Rohtak district which was estimated with the help of auxiliary character, cultivated area. The sampling unit for the study is considered a village. The efficiency of DUBSS is compared with the traditional techniques and CUBBS technique by carrying out a suitable simulation study. The proposed technique performs considerably better than all the other techniques.

T1.7.3: Spatio-temporal analysis of paddy and wheat residue burning in north India during 2018-19 using satellite remote sensing (Abstract Id: A1-1-053)

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In the Indo-Gangetic Plains (IGP) of India, about 12 Mha area is under rice-wheat system and harvesting of these crops with a machine 'Combine harvester' is very popular with the farmers of Punjab, Haryana and Uttar Pradesh. With a sizeable area and production, these crops produce a large amount of crop residues. However, a large portion of these residues is burned on-farm primarily to clear the fields to facilitate planting of succeeding crops. The problem of on-farm burning of residues has further intensified in recent years due to unavailability of labour, high cost in removing the residues by conventional methods and use of combine harvesters. Crop residue burning has serious impacts on environmental pollution, fertility of soils and health of human and animals in the concerned areas and their neighbourhood. During 2018, a Central scheme was implemented in these states by providing subsidy to farmers' to provide suitable machinery and other interventions, coordinated through State Agriculture Departments. To monitor the success of scheme, real-time spatio-temporal information was required on residue burning events. On behalf of ICAR, spatio-temporal monitoring of the active fires due to paddy and wheat residue burning was carried out in real- time for all the three states from 1- Oct to 30-Nov 2018 for paddy and 15-April to 31- May 2019 for wheat, on daily basis and their comparison was made with events during 2017 and 2016. Thermal image from seven satellites acquired at the IARI satellite ground station were used for the detection of fires for both day and night passes. Daily bulletin of fire events were prepared and burning locations were put on KRISHI Geoportal (http://geoportal.icar.gov.in:8080/geoexplorer/composer/) for visualization as maps. Total paddy area burnt was also estimated for Punjab and Haryana using Sentinel-2A satellite imageries. Analysis showed continuing practice of residue burning with a total of 75,563 burning events from 1- Oct to 30-Nov, distributed as 59695, 9232 and 6636 among Punjab, Haryana and UP, respectively. Maximum burning occurred between 28-Oct and 10-Nov in the three states. Significant reduction of 15% and 41% in fire events was observed in 2018 than in 2017 and 2016, respectively.

Using high resolution images it was estimated that 49% paddy area and 45% of straw produced was burnt in Punjab in 2018. In Haryana, remote sensing estimated 1.27 Mha area planted, out of which 0.25 Mha area was burnt in 2018 i.e. about 19%. About 9 Mt of paddy straw produced on dry weight basis, out of

which 1.7 Mt was burnt in 2018 i.e. 17%. Developed a model based on remote sensing detected fire power of event and estimated emission of pollutants (particulate matter) and Green House Gases (CO2, CO, NOx, CH4) from residue burning for different districts in three states. Similar analysis was carried for wheat crop in the three States. The numbers of wheat burning events were comparatively lower than that of paddy. Even though there was small reduction in wheat burning incidents in Punjab in 2018 over 2017, it increased significantly in Haryana and Uttar Pradesh.

T1.7.4: Improving paddy rice statistics using area sampling frame technique (Abstract Id: A1-1-013)

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Agricultural surveys typically use a list frame as the main sampling frame to identify and access the elements of the target population. List frames are built on the basis of information from administrative records and data from recently conducted censuses. While the efficiency of survey implementation may be affected by the overall survey process, frame quality has a major effect on the quality of statistics produced. In most developing countries, a complete frame with updated and comprehensive holding information may not be available, leading to under-coverage and biased estimates. To circumvent these issues, the Asian Development Bank evaluated the usefulness of an area sampling frame developed using technological advances in satellite imagery and geographic information system techniques for estimating paddy rice area and production in a study that was piloted in three major rice producing provinces in Southeast Asia—Savannakhet, Lao PDR; Ang Thong, Thailand; and Thai Binh, Viet Nam. The study employed a three-stage stratified sampling technique for which the sampling frame used was developed using freely available MODIS and Landsat data on land cover and land use. Direct estimates of total paddy rice area and production are calculated from area frame using two methods—one involving measurement of plot size using a global positioning system instrument and the other utilizing a digitized map of farmer-identified plot boundaries on a high-resolution Google Earth image. A third method involving the calculation of ratio estimates using independent mesh-level measures is compared with the first two methods involving direct estimates, and with the estimates generated from administrative data from the countries. Our study finds that ratio estimation significantly improves the level of precision of paddy rice statistics. Significant deviations for paddy rice area, production, and yield are also observed between official statistics and the statistics generated through direct estimation. Nonetheless, the estimates are likely more reliable when compared to official estimates since satellite-based estimation methodology is transparent, reduces under-coverage and allowed for calculation of confidence interval. It is also necessary to improve the land-use stratification of the frame by using higher-resolution satellite images and a greater power of discrimination in the models used for defining the strata. Sentinel 1 and Sentinel 2, which have better resolution than existing freely available satellite images at the time of the study, are likely candidates for future research.

T1.7.5: Post-sampling crowdsourced data to allow reliable statistical inference: The case of food market prices in Nigeria (Abstract Id: A1-1-040)

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Sound agricultural policies and decision making in developing countries are often limited by the lack of timely and reliable data. In many instances it is crucial to be able to avail reliable datasets at a geographical scale so as to target geographically the resources. In food insecure areas or in areas of poor accessibility, crowdsourced data may provide a valuable alternative for timely data collection and analysis when traditional methods are more difficult or too costly. However, voluntarily crowdsourced data do not obey any formal sample design and can be considered just a convenience sampling due to the self-selection bias inherent to the process of data collection. As a consequence, no probability of inclusion can be calculated and the data cannot be directly used to draw sound statistical inference. To overcome this problem, in this paper we propose the use of a special form of post-stratification with which crowdsourced data can be manipulated and reweighted so as to resemble a formal spatial sampling design. In particular, we consider two benchmarking designs: (i) a random stratified sample design (with geographical stratification) and (ii) an optimal spatial sampling design which take into account spatial correlation such as the DUST technique (Arbia, 1993 and Arbia et al., 1991) and the Local Pivotal method 2 proposed by Grafström et al. (2012). We show that through the comparison with a spatial sampling design formally defined we are able to derive a set of post-sampling weights which can be used in an inferential context to re-weight areas of under- over- representativeness of the sample and obtain more accurate estimates. The paper also contains a test of the methodology based on simulated data together with an example based on real food price data collected through crowdsourcing in Nigeria in the period September 2018 - May 2019 which illustrate the applicability of the method in empirical situations. The proposed method responds to recent calls for diversifying data sources by integrating ICT and new methodologies in data collection activities.

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Session T1.8: Analytical Techniques to Assess Agricultural Performance

T1.8.1: Methods of Data Analysis Used in Measuring the Performance of Agriculture (Abstract Id: A1-1-004)

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The United Nations has forecast that, over the next two decades, the world population will increase to 9.3 billion and that food requirements will increase by 50–70%. Good farm management and agronomic practices, in combination with efficient input use, are the best ways to improve farm productivity. Growth in agricultural production is a topic of continuing interest to researchers and policymakers who aim to better the economic efficiency and economic sustainability of primary agriculture. Thus, it is important to understand the performances of the small-scale farms. Cost reduction and increased profitability are major factors that farmers consider when deciding on agronomic practices. Farms that incur high costs per unit of production or otherwise achieve low profits may have the potential to improve their performance. Consequently, it is important to estimate the performance levels of the farms and to understand the factors affecting their economic performance to suggest possible improvements to agricultural production and productivity. The estimated efficiency level can be used to identify under-performing producers and to identify farms using the best management and agronomic practices. This information, in turn, is useful in helping to design agricultural policies and extension programmes, aimed at improving the overall performance of the agricultural sector. There are two main statistics methods in the literature for measuring farm performance: i.e. a parametric (econometric) approach such as the SFA, and a non-parametric approach, such as data envelopment analysis (DEA). In both methods, the basis for performance measurement is the radial contraction/expansion connecting inefficient observed points with (unobserved) reference points on the production frontier. For a sample of producers, both approaches involve estimating the 'best-practice' frontier for a specific industry or group of farms. If the actual production point of a farm lies on the frontier, it is perfectly efficient; if it lies below the frontier, then it is inefficient. The choice of estimation method has been an issue of debate and each approach has its advantages and disadvantages. This paper reviews the two most commonly used methods of data analysis used in measuring the performance of agriculture using survey data.

T1.8.2: Econometric modeling of acreages under major food grain crops factoring in the spatial effects of rainfall. (Abstract Id: A1-1-030)

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India's food production is the result of individual decisions taken independently by millions of farmers operating across geographically diverse country. Early outlook on food production is important for informed policy making. India also carries memories of food shortage. Countries around the world are moving towards greater communication about food security outlook through scientific methods. As Indian economy grows and adapts to globalization, continual monitoring of production will become a critical function of the government for managing the economy. Acreage under any crop is a primary indication of farmer's production target. In recent times, policy objective for agricultural development is shifting towards farmers' welfare which means that farmers are able to get the best prices. Producing the right quantity of different products will help farmers to meet national demands, access the larger world market and prevent large falls of

prices. In market driven economy, the area allocated to different crops would be sensitive to movements in market prices, but water will remain to be important for crop planting. Some crops having more modest demand for water and are hurt by poor drainage at the sowing time than others. Water available to crops depend not only on rainfall in the growing site but also irrigation which in turn depends on rainfall in past seasons and in other states associated with irrigation infrastructure and hydrological features. An econometric model has been designed to explain acreages under major food grain crops using recent time-series data of major growing states.

Commercial incentive is specified as the price of the crop relative to possible substitute crops in the study state. Rainfall, specified by the meteorological regions in the states, can act on the crop acreage by its interaction with irrigation facilities and water sharing arrangements. The acreage model is taken to be dynamic, so that past practices also drive the decision on sowing a crop. Simplistically, a good monsoon produces a bumper harvest and scanty rainfall causes crop failure but econometric modelling of past data shows that the reality is much more complex. Food production in a state is sensitive to rainfall in the state as well as in other states and effect is not always favorable. The results identify certain meteorological regions whose rainfall in past or sowing season have greater potency in deciding the cropping pattern in the country than others. All crops are sensitive to prices though the crops competing for acreage vary across states.

T1.8.3: Spatio-temporal data mining of crop yields in India to assess agricultural performance
(Abstract Id: A3-5-028)

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Crop yields are the primary indicators of performance for agriculture in a region based on a range of biophysical and crop management practices in vogue. While the agro-ecological aspects of cropping systems are well understood and modelled in many of the crop yield forecasting models, the impact of the variations in the cropping practices, including training and access to resources, is poorly documented or studied. Even when the latter is documented well, quantifying its impact on the crop outcomes is a challenge and hence there is a need to assess crop yields over long periods of time. Hence, this paper proposes an analytical method that evaluates the behaviour of the data across space and time using a spatio-temporal data mining method, MiSTIC, to assess the productivity of the cropping systems and its temporal consistency. The current study uses the district level yield dataset of paddy in kharif season across India for the period 2000 to 2010. The method helps cluster a set of districts into zones, with each zone further divided into nearly concentric sub-zones of similar performers based on the empirical rule. The results for paddy in the Kharif season show that there are 18 production zones across India, except the districts of North East and Jammu and Kashmir, with zonal averages ranging from 861.9 kg/ha to 3076.3 kg/ha. An interesting finding is that irrespective of input variations including soil, climate and other factors, there are homogeneous groups of districts with similar yield performances and that they don't show any significant upward or downward trend over the time period. This may indicate that the high and low performers might be more strongly influenced by other regulatory and controlling factors at a regional scale. The developed spatio-temporal data mining method is scale independent and can be applied at more finer scales too.

T1.8.4: Towards sustainable food production systems in Qatar: Assessment of the viability of aquaponics
(Abstract Id: A6-8-016)

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The United Nations Sustainable Development Goals (SDGs) 2030 were formulated to facilitate addressing the most pressing issues of the past decade mainly: population growth, climate change, soil degradation, water scarcity and food security. Moreover, feeding the growing population requires more food production while minimizing food waste. This has resulted in greater use of water and synthetic fertilizer in agriculture. Given that only 2.5% of aggregate water resources is freshwater, and moreover only 0.3% of the 2.5% is readily available for human consumption, yet 70% of the 2.5% this limited amount of freshwater available is used for agriculture, ensuring food is production is done sustainability has become a high priority. Recent evidence suggests that water scarcity is already a pressing global issue that is affecting more than 40% of global population. Current future projections estimate that by 2025, an approximate 1.8 billion people will be living in countries or regions with absolute water scarcity. After blockade, Qatar gives attention to food production and self-satisfaction and in one year achieved unexpected success in food production and resources that allocated to food security. for instance vegetables, dates, red meat, poultry, eggs, fish, doubled to reach 400% from 2017 to 2018.an amount of 70 million QR have been allocated as annual support of agricultural production for the next five years. In addition to three research centers to assist in production and protection of animal, fish and Hubari birds and agricultural extension. The ministry of municipality and environment is adapting a major strategic project for agricultural production that include an area of one millions squire meters per project per projects. Sustainable food production requires a sustainable production system. Hence the implementation of aquaponics has the potential to support partially meet Qatar's food requirements in an environmentally sustainable manner. In the event a country economy's is exposed to unexpected economic shock such as economic sanctions or blockade, this country may go for short term strategies in order to meet such an eventuality in a record time so as to live the new situation. However, short-term strategies produce long-term negative effects that are difficult to control and sometime irreversible such as the adverse impact on the environment and natural resources. In this educated policy paper, we reviewed the current agricultural strategies of Qatar and assessed the viability and possibility of adapting sustainable agricultural production systems such as "Aquaponics" in Qatar. In addition, we identified the pressing challenging issues facing food production before and after blockade. This paper aims to give information that may help understanding of sustainability in agricultural and food systems. We also discussed some environmental negative effects that to be considered when adapting a new sustainable agricultural system. Although Qatar strategy is giving more attention to food-security and huge financial resources allocated for agriculture; this is the first research attempts on sustainable agricultural system. The gap in sustainable agricultural research is particularly large in Qatar.

Sub-Theme T2: Data Sources/Data Collection/Data Quality

Session T2.1: Agricultural Census in the Framework of an Integrated Data Collection System(1)

T2.1.1: Agricultural census in the Russian federation, experience and prospects in the SDG framework (Abstract Id: A12-13-016)

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According to the Russian legislation, agricultural censuses are conducted once in 10 years. The previous agricultural census was held in 2016. The concept of the 2016 Russian Agricultural Census (RAC), its structure and methodology were based both on the FAO UN recommendations and best-practices of 2006 RAC. The census covered all categories of agricultural producers: 1. agricultural organizations (not small businesses, but small enterprises, including micro-enterprises); 2. peasant farms and individual entrepreneurs; 3. personal subsidiary and other individual farms in rural and urban areas; 4. horticultural, gardening and dacha non-profit associations. The RAC results covered the Russian Federation, constituent entities and municipalities. They gave us the opportunity to assess structural changes of the Russian agriculture in 10 years (since the first RAC). Census results also served the basis for update of general populations by categories of agricultural producers (agricultural organizations, including small businesses, peasant farms, personal subsidiary farms). According to the RAC results, a complex of works was carried out to identify discrepancies in census results with the statistical reporting data by individual indicators. Also recalculations of retrospective time series were carried out for the inter-census period 2007-2016 by sawn areas of main agricultural crops, livestock numbers, agricultural production in physical and monetary terms, agricultural production indices. The balances of food resources (potatoes, vegetables, fruits and berries, meat and meat products, milk and dairy products, etc.) were updated. In order to improve the quality of agricultural statistics in the inter-census period, the Russian legislation was amended by a regulatory norm on the agricultural micro census, stating that it should be carried out in the middle of the inter-census period. An introduction of the agricultural micro census into statistical practice makes it possible to exclude time series recalculations. Conduction of the agricultural census on a regular basis will contribute to qualitative monitoring of a number of important SDG indicators. With households producing over 30% of gross agricultural output, conduction of a regular census may solve the problems of time series recalculations and discrepancies in census results with the statistical reporting data. After the agricultural micro census, Rosstat plans to switch from a combined large category of small agricultural producers (28 million) to a regular census (for example, 10 percent of the total population objects per year) with consecutive coverage of the entire general population during 10 years.

T2.1.2: Linking agricultural census with population and housing censuses in Georgia (Abstract Id: A2-2-027)

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The paper will describe the experience of Georgia in linking Agricultural Censuses with Population and Housing Censuses, and producing agricultural statistics in the framework of an integrated system of

agricultural censuses and surveys. The Law of Georgia on Official Statistics creates a general legal framework for statistical system in the country. National Statistics Office of Georgia (Geostat) is a coordinating body of the National Statistical System and the only producer of official agricultural statistics. Geostat is responsible for conducting population, housing and agricultural censuses. Agriculture has always been one of the important sectors of Georgian economy. Share of rural population is 43% and almost all households in rural areas are engaged in agricultural production activities. Share of agriculture, hunting, forestry and fishing in GDP is 7.7% and almost half of employees are employed in the agricultural sector. The main road map for improving agricultural statistics in the country is the Strategic Plan for Agricultural, Environmental and Rural Statistics, 2016-2020 (SPAERS) elaborated with technical assistance of FAO and USDA. The first Agricultural Census in the history of independent Georgia was conducted in 2004. After 10 years, in 2014 Geostat conducted the Agricultural Census together with the General Population Census. The integrated General Census programme contained the following questionnaires: Questionnaire on Dwelling, Personal Questionnaire, Questionnaire on Migrants and Questionnaire on Agriculture. In addition, census identified holdings operating in aquaculture sector. In order to ensure full coverage of agricultural producers, the agricultural census data collection included also the holdings in the non-household sector (including common land data collected from rural communities). The paper will also review building the Master Sample Frame for agricultural and rural statistics. The data derived from the General Census are used to build the Master Sampling Frame. Census was conducted using the GIS maps, thus, all the data derived from the census are linked to the GIS data. As it was derived from the integration of Population and Agricultural Census, the Master Sample Frame is very comprehensive and can be used for many different surveys. The paper will present the benefits of conducting joint agricultural and population censuses and the core set of variables which are derived from the census, and it will provide examples of surveys which can be based on the Master Sample Frame. The main source of current agricultural statistics is the Sample Survey of Agricultural Holdings. In 2018 CAPI method was adopted to collect agricultural survey data. With technical assistance of FAO, Geostat is implementing AGRIS in its current agricultural survey program. The paper will reflect the experience of Georgia regarding benefits and expected results of implementing CAPI as well as AGRIS in agricultural surveys. Author: Vasil Tsakadze, Head of Agricultural and Environment Statistics Department, National Statistics Office of Georgia.

T2.1.3: New methodological solutions for the implementation of agricultural census 2020 in Hungary (Abstract Id: A2-2-022)

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The current Hungarian data collection system for agricultural statistics has been unchanged since the 1990s, and there are some basic elements (e.g. threshold) that have not been changed since 1972. In the recent decades, the form of backyard farming and its role in the production of agricultural products has changed fundamentally in Hungary. The existing data collection system is based on house-to-house survey and uses one of the lowest thresholds in the EU. It is clear that a methodological improvement is needed to produce cost-effective data for today's Hungarian agriculture and to reduce the burden on respondents. Agricultural Census 2020 will be carried out in Hungary in June 2020. The Hungarian Central Statistical Office introduces a recently developed data collection system with a completely new methodology. The following main changes are planned to be implemented in the Hungarian agricultural statistical system: modified farm thresholds; new Farm Register with an intensive use of administrative registers and accuracy of geocoding/geolocation of farms will be improved. The census serves as a basis for the implementation of agricultural surveys for the period 2020-2030 and determines the methodology for the semi-annual agricultural surveys. In the paper, the new methodology will be described where a

more targeted data collection, improved data quality, the reduction of costs and burden on respondents will be realized.

T2.1.4: The census of agriculture in the Canadian Statistical System: Adapting to an evolving context (Abstract Id: A2-2-010)

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Since the very first quinquennial Census of Agriculture program conducted at national level in 1956, it has been recognized that its integration with the rest of the statistical system, and primarily with the Agriculture Statistics Program, was essential to provide critical accurate statistical information in support of the agriculture sector to decisions and to support government programs. Up until the 2016 Census of Agriculture, this integration was fundamental to improve Statistics Canada's Business Register, which is the common frame for the surveys and censuses that produce economic statistics. The Business Register comprises all units in all economic sectors involved in economic production in Canada. An adequate coverage of agricultural operations in the Register lead to the use smaller samples to produce statistically reliable estimates, which in turn reduces response burden. The Census of Agriculture data are also used as benchmarking data to reconcile and revise common statistics and indicators in the Agriculture Statistics Program. These processes are essential to maintain high-quality current data throughout the entire Agriculture Statistics Program. These high-quality data are integrated into the production and publication of economic data on the agricultural sector in the Canadian System of Macroeconomic Accounts (such as gross domestic product, input-output tables and the value of assets). The Census of Agriculture also leverages the integration of data coming from other agriculture programs or from centrally managed administrative data (e.g. tax data) in various statistical processes (imputation, validation, certification and dissemination). The Census of Agriculture also benefits from its integration with the Canadian Census of Population. Since the Census of Agriculture is conducted simultaneously with the Census of Population, the Census of Agriculture can benefit from a wider audience and the associated communications activities, resulting in a higher response rate and increased coverage at a lower cost. The Census of Agriculture is also capitalizing on the Census of Population for collection, printing and contract management. Data linkages between these two programs provide a rich and detailed socio-economic portrait of the agriculture sector. While the Census of Agriculture is well integrated with the entire Agriculture Statistics Program, its integration with the rest of the statistical system needs to be brought to the next level. Data users, policy makers and farmers want high-quality, real-time data and analyses beyond the primary sector to make informed decisions. Furthermore, Canadian farms have evolved to become increasingly integrated and complex businesses. Processing farm and ranch data is now best handled within the Business Surveys processing infrastructure than the social survey processes traditionally employed. The migration and integration of the Census of Agriculture Program with the generic Business Surveys concepts, processing platforms and their leading-edge methods is essential to respond to this new context but also open a realm of opportunities for the next Censuses of Agriculture. This will support the massive integration of administrative, modeled, earth observation, sensor and other program's data to replace respondent data and produce new relevant statistics more frequently and more integrated with the other sectors of the economy.

T2.1.5: The Modern 2020 Agricultural Census in Spain: An Innovative Approach for a Massive Use of Administrative Sources in an Integrated Statistical System (Abstract Id: A2-2-005)

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The next agricultural census will be held in Spain with reference to 2020 within the European Union Regulation 2018/1091 of the European Parliament and of the Council of 18 July 2018 on Integrated Farms Statistics. The Regulation establishes a framework for the European Statistics at the level of agricultural holdings and provides for the integration of information on the structure with other data on production methods, rural development agro-environmental aspects and other related information. The agricultural census is carried out every ten years and is a key priority for both, the European Statistical System and Spain. At the European Union level, the agricultural census is a key tool to examine the trends in the structure of agricultural holdings at the Union level and to provide the statistical knowledge base for the common agricultural policy. At national level, the agricultural census is essential for the government proper decision making and for users. In addition, the agricultural census provides relevant information for statistical operations in the agricultural field and the elaboration of the economic accounts for the agriculture. For the first time in Spain, the agricultural census will be held from an innovative approach for a massive use of administrative records in a close and broad collaboration among different institutions of the Spanish Statistical System based on new agreements to include statistical census core variables in the administrative registers. The new procedure will allow both, the elaboration of a quality census framework and a direct use of administrative records to partially avoid direct collection of information. In particular, for those units of the census framework (approximately one million agricultural holdings) which are included in the administrative records for the single application of the common agricultural policy (65%-70% of the directory), declarations will be used to fulfil all the requirements of annex 3 regarding the Regulation core structural data (core data). This administrative source, however, does not contain information from those farms that do not request for UE funds and it does not allow to give reply to the requirements of annex 4 (with reference to 2020, mainly module data on labour force and other gainful activities, animal housing and manure management). For these reasons, additional administrative sources (among others, registers on livestock, agricultural production, insurances, vineyards, fruits and vegetables, taxes or social security records) and statistical surveys by using a multichannel way to capture data (through CAWI-Computer Assistance Web Interview-, CATI-Computer Assistance Telephone Interview- and CAPI-Computer Assistance Personal Interview- will be also used. In addition, new innovate methods to conciliate data from administrative sources and direct data collection from statistical surveys will be implemented. During 2019, a pilot study will be carried out. By using a combination of administrative sources, statistical surveys and innovate methods, the described approach will allow a significant decrease in the cost of the operation (around 15 million euros: total approximate cost of 15 million euros compared with more than 30 million euros of the previous census) and a significant reduction of the response burden on respondents.

Session T2.2: Agricultural Census in the Framework of an Integrated Data Collection System (2)

T2.2.1: Adapting agricultural census modalities to new requirements in an integrated system of data collection (Abstract Id: A2-2-037)

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The growing demand for more and coherent data and the scarcity of resources for census taking on the one hand, and the development of new technologies on the other hand, create new challenges and opportunities in conducting the censuses of agriculture. The changing environment and data requirements have led some countries to review their agriculture statistics programme, including the agricultural census methodology.

Addressing countries' needs, the World Programme for the Census of Agriculture (WCA) 2020 discusses different modalities for conducting an agricultural census, i.e.: (i) classical approach, (ii) modular approach, (iii) the integrated census and survey programme modality, and (iv) use of registers as a source of census data. The second census approach was introduced in the WCA 2010 and the latter two modalities - in the WCA 2020. Most countries continue using the classical census approach, however, the alternative census modalities become more and more attractive for countries. In countries with well-developed registers and a good cooperation between the census agency and the holders of administrative data sources, there is an increased use of registers to cover census data items. Countries such as Denmark, Estonia, France, Hungary, Latvia, Lithuania, the Netherlands and Norway extensively used the administrative data in their latest census. The use of registers is beneficial for decreasing the census budget, but also the burden on respondents. In addition, it contributes to a better integration of statistical and administrative data sources in terms of scope, coverage, concepts, definitions, classifications applied, periodicity and timeliness. The modular census and the integrated census and survey modality aim at helping those countries where the agricultural census and survey programme is not well-developed to produce, in a cost-effective way, a wide range of data on various dimensions of the agricultural sector. An example of using the integrated census and survey modality is the FAO Agricultural Integrated Survey (AGRIS) programme. An increasing number of countries link the agricultural census (AC) with other censuses, especially with the population censuses (PC). Integrating the AC and PC, in particular, can vary from standardisation of census tools to sharing field materials and even to joint data collection for the common – household sector. Many countries, such as Fiji, Ghana, Nepal, Serbia, Mauritius, Mozambique, included in the PC some screening questions aimed at identifying the agricultural holdings. An agriculture module (AM) was piggy-backed onto the PC in countries such as Burkina Faso, Senegal, Seychelles and Uganda, to provide a more complete frame for the follow-up supplementary census modules. The strongest link between the two censuses was observed when both censuses were undertaken together as a joint operation, as in Canada, Georgia or Poland. Some countries, such as Brazil, Cook Islands, Japan and Philippines conduct combined agricultural, forestry or aquaculture/fisheries censuses. Bangladesh collected agricultural census items in the framework of the economic census. The article provides a summary of national practices with respect to census modalities used by countries for conducting agricultural censuses in the WCA 2010 round, depending on specific census objectives, availability of resources and country traditions.

T2.2.2: Coordination of agricultural censuses with population censuses and other statistical data collections (Abstract Id: A2-2-011)

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As defined in the World Programme for the Census of Agriculture 2020 (WCA 2020) , "a census of agriculture is a statistical operation for collecting, processing and disseminating data on the structure of agriculture, covering the whole or a significant part of a country". It is a comprehensive data collection exercise and one of the key pillars of a national statistical system. Agricultural census covers two broad sectors, the household sector and the non-household sector. Holdings in the household sector are those operated by household members. Non-household sector includes the agricultural holdings such as corporations and government institutions. By this, it has unique natural linkages to both household-based surveys and enterprise surveys, thus to two other comprehensive census exercises in a country: population and housing census and economic census. The first part of the paper will focus on various aspects of coordination of an agricultural census with a population and housing census on one hand, and an economic census on the other hand. Agricultural holding, the statistical unit of the agricultural census, when belonging to the household sector, is closely linked to household, statistical unit of the population and housing census, most often these two unites being in on-to-one correspondence. This allows various degrees of coordination between the two censuses, from using common concepts, definitions and classifications and sharing field materials to including key agricultural items in the population and housing census or even to joint data collections. On the other hand, the concept of the agricultural holding is compatible with the concept of the establishment, which is the statistical unit of the economic census. This allows close coordination of the two censuses, especially for agricultural holdings in the non-household sector. The second part of the paper will discuss the aspects of integration of the agricultural census into the system of agricultural statistics, through integrated agricultural census and survey programme. This is proposed as one of the census modalities in WCA 2020. Agricultural Integrated Survey (AGRIS) concept, developed under Global Strategy to Improve Agricultural and Rural Statistics and currently supported by FAO in various countries, will be discussed as one of the ways of implementation of this modality. The issues discussed in the paper are quite topical, because in recent years increasing efforts have been made towards the better integration of statistical activities. Integration, in a statistical sense, means that each statistical collection is carried out, not in isolation, but as a component of the national statistics system. An integrated statistics system allows avoiding duplication in statistical activities and release of conflicting statistics. It also allows using compatible concepts, definitions and classifications in the different statistical activities thus making it easier to interpret and analyse related data from different sources. Theoretical discussions in the paper will be complemented and supported by various country examples from Europe and Central Asia region.

T2.2.3: Multiple data sources for agricultural census in Finland (Abstract Id: A2-2-040)

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Sampling Frame Natural Resources Institute Finland, Luke is responsible for the implementation of agricultural census 2020. The statistical farm register is the frame for agricultural census. We update our statistical farm register yearly. This register is up-to-date covering in practice all active farms in Finland.

The main data sources of this register are administrative registers, horticultural survey and tax data. Data collection Administrative data will be used as much as possible in order to decrease response burden. In addition we will study if it is possible to build up new web based data collection system, which will provide feedback to data providers (mydata service). The target is to increase the number of web-responses and decrease the need for telephone surveys leading to lower survey costs. Data collection of core variables is census and for other variables we will use sample survey. Direct data collection consists of two methods. At the beginning we will use web-based data collection (CAWI). In second phase we will use telephone interviewing (CATI) for the farms which did not answer by web-based data collection. For example number of livestock and crop areas will be taken from administrative data. In Finland, all farms have a unique farm identification number in Agricultural and Horticultural Enterptise register. The same identification number is in use in administrative registers in agricultural sector. Therefore it is reliable to merge administrative and data collected by survey by using this identification number. Other data sources Data from the Finnish field parcel register of IACS will be used to define the farm-specific field area that is included in crop rotation. The register includes geospatial data that indicates the location individual crops within a field parcel. In our earlier project, the geospatial data and the possibilities to use it were recognized. In addition we will use the register of examinations to find out farmer's agricultural education. This data will be merged to agricultural census data by farmer's social security number. Furthermore we will use Business Register data when we study other activities of the farm.

T2.2.4: Census of Agriculture: Which lessons learnt through years? Case of Botswana (Abstract Id: A2-2-038)

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The 2015 Botswana Agricultural Census was the fourth census of its kind. The first, second and third one were conducted in 1982, 1993 and 2004 respectively. Census of Agriculture is the main source of agricultural structural data as part of the National Statistics System. Census of Agriculture provides informed data, useful for both stakeholders and data producers (FAO, 2017). Agriculture in Botswana consists of two distinct sectors, namely the traditional sector (also known as subsistence agriculture) and the commercial sector. The agricultural census carried out in 2015 covered both sectors. The Sampling Frame for traditional sector data collection was 1,328 Enumeration Areas (EAs), which was constructed from the demarcated 2011 Population and Housing Census frame. The sampling frame for commercial sector was made up of a list of freehold, leased and TGLP farms or ranches obtained from the Establishment and Enterprise Register (EER) at Statistics Botswana, supplemented by a list of commercial farms obtained by Ministry of Agriculture enumerators during annual agricultural surveys and a list of farms\ranches provided by the Department of Animal Health and Production (DAHP), through its extension services. A total of 62 975 and 1 578 holdings were covered for traditional and commercial holdings respectively. This paper aims at describing the lessons learnt through the agricultural census years and how FAO recommendations through the World Programme for the Census of Agriculture (WCA) have been adapted to local context for each round.

T2.2.5: Framework for implementation of agriculture census in Bosnia and Herzegovina – state of play, chalenges and posible solutions (Abstract Id: A2-2-015)

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Agricultural Sector is one of the most important sectors of economy in Bosnia and Herzegovina. It is characterised by a huge number of small agricultural holdings that significantly contributes to the GDP of the country (8,4%). Although the Agricultural census has not been implemented, statistical institutions in Bosnia and Herzegovina estimate that a significant part of the BH population lives in rural, agricultural areas. The lack of reliable and accurate agricultural, but also cadastral data creates development policies and strategies difficult, if not impossible. The last Agricultural Census in the Social Republic of Bosnia and Herzegovina was carried out in 1960. During the Population Census in 1971, 1981 and 1991, some limited data on agriculture were collected. In the period from 1992 to 1995, there was no collection or publication of any data on agricultural statistics due to war events in BiH. This means that the last, full Agricultural Census was carried out more than 50 years ago. Following the FAO recommendations, BiH made a link with the 2013 Population Census with the future Agricultural Census, as the P-2 form of the Census Questionnaire contained basic questions on agriculture (filter questions) in order to identify agricultural households. Based on the results of the Population Census in BiH in 2013, the Address book of about 364,000 agricultural holdings was established. In the decade 2010, BiH did not conduct the Agricultural Census. It is planned to be conducted in the decade 2020. It is necessary to define the framework for the future Census of Agriculture using the Census results of 2013. Given that the framework is quite old (6 years), there are two options that are analysed in this paper: Option 1) the use of results from Population Census 2013 - households with agricultural production Option 2) the use of results from Population Census 2013 - households with agricultural production in urban areas, including a list of all households in rural areas (door to door) According to the results from the surveys, the two alternatives require a significantly different budget, since the number of visiting households in the option 2 is almost double comparing to the option 1 (360,000 versus 650,000). Previous analyses and surveys should argue the choice of one of the options. In order to make a hi-quality decision, the solution may be to conduct Coverage Surveys (Quality Control Coverage) based on a door-to-door survey on the enumeration area sample, which is one of the s of this paper. The mentioned survey would be a key activity in the preparatory phase of the Agricultural Census 2021. The questionnaire would contain identical household identifiers from the Population Census 2013, including identical agricultural variables. The result of this research could be an important contribution in deciding on the framework for the future Census of Agriculture and for the calculation of the necessary resources (budgets) for the future Agricultural Census.

Session T2.3: Cost-efficient Censuses of Agriculture

T2.3.1: Technology in support of efficient agriculture census data collection and dissemination (Abstract Id: A2-2-029)

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Comprising of 36 provinces/Union Territories in the country at the first administrative level, about 700 districts at the second level and more than 6000 blocks at the third level, agriculture census taking in India is a complex and gigantic exercise spread over a period of three years with the involvement of about 100,000 primary workers. Government of India has been conducting agriculture censuses in the country regularly every five years since 1971. One unique feature of this census is the use of administrative land records available with the provincial land record Departments to generate structural statistics covering number and area of operational holdings classified by size class and social groups, tenancy, land use, crop wise area and data on inputs use on the holding including ancillary information on the soil health, credit, use of agricultural implements etc. In the recent times, while the processing and dissemination of census results have already been computerized and data available online, the data collection stage continues in the manual mode with use of paper questionnaires by the primary workers. Coupled with the coordination issues in the federal set up and different stages of development of statistical machinery in the provinces, a major consequence of manual data collection is that data entry, processing and dissemination takes inordinately long time sometimes more than three years to publish final results. Use of hand held devices to collect data at the village level can significantly improve this time lag and also enable better data quality monitoring and compliance. At present, data is collected using PAPI approach at the village level which is manually aggregated at the Tehsil level and computerized for each tehsil. thereafter tables are generated at district, province and national level. Considering the size of the country, adoption of this technology will require careful consideration of financial and administrative aspects as well as training needs of the agriculture census taking staff and manage process change for its sustenance. Besides above, there are many other areas for improvement which can make the agriculture census taking more efficient, enable more data collection at small area level for SDG monitoring and make data more reliable. Some of these areas include mandatory implementation of complete enumeration approach in the phase-1 both for land record and non land record provinces, generating village level tables in place of Tehsil level tables, extraction of computerized land records data for generating pre-filled soft copies of schedules for use by the primary workers and technological solutions for ensuring data quality and cross validation. This paper discusses the technical, operational and organizational issues surrounding the adoption of latest technologies for agriculture census data collection processing and dissemination in the overall framework of integrated system of agriculture census and follow up surveys in the country..

T2.3.2: 2017 Brazilian census of agriculture: Strategies to mitigate the impacts of budgetary constraints (Abstract Id: A2-2-023)

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A classic census of agriculture is an expensive statistical operation, even in small countries. In the case of Brazil, with more than 8.5 million square kilometers of territorial area and around 5 million farms, its

fulfillment is a huge challenge. Since 1940, IBGE has been conducting census of agriculture. Since the 1990s, difficulties in securing its budget have led to cancellations (1990 and 2000) and postponements (2016). In the last two censuses (1995/96 and 2006), the budget was reached thanks to the integration with simultaneous operations to the agricultural census: a population count (1996/2007) and a construction (1996) and update (2007) of a List of addresses for statistical purposes. The Census of Agriculture 2016 was planned as a single operation and its financing of about R$ 1.4 billion (~ US $ 405 million) was unsuccessful until 2015. By 2016, an initial budget of R$ 530 million was proposed by the government for the census. Although this value represents only 40% of the initially planned, the agricultural census is highly valuable for the Brazilian statistical system and therefore should not be canceled. The demands for statistical information, the high dynamics of the structure of agriculture, and the role of this activity in the Brazilian economy were other important factors considered to face these limitations and try to guarantee the completion of the census. Under such conditions, all strategies planned for the agricultural census had to be revised to mitigate the impacts of budgetary constraints: date and reference period, size of the questionnaire, field supervision, data collection logistics, interviewers, hardware investments, etc. The project was reviewed and data collection from the Census of Agriculture 2017 began on October 1, 2017. This document describes these strategies and evaluates their effectiveness and impacts on the overall operation.

T2.3.3: Streamlining the cost of the census of agriculture (Abstract Id: A2-2-008)

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As public-sector budgets tighten, producers of agricultural statistics are coming under increasing pressure to justify the budget of producing statistics and reduce costs. This is particular the case of large statistical operations such as the census of population and the census of agriculture. The agricultural census could be made more cost-efficient by (i) closely monitoring and controlling the work plan and budget; (ii) using adequate census methodologies suitable for country-specific agricultural sector conditions; (iii) streamlining the census questionnaire to focus on structural items; (iv) adopting new technologies for frame construction, data collection (e.g CAPI), data archiving and preservation, and wider data dissemination (online products). The paper discusses these approaches conducive to improve the cost efficiency of the agricultural census while ensuring data quality.

T2.3.4: The agriculture-zero project and the Canadian census of agriculture (Abstract Id: A2-2-009)

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The Canadian Agriculture Statistics Program which comprises the Census of Agriculture and a combination of 40 production and financial programs is undergoing a major transformation. In order to meet the demand of agriculture data users for broader, more timely, more frequent and more granular statistics while maintaining the high standard of quality and controlling the cost, Statistics Canada is implementing the Agriculture-Zero project (zero contact with respondents). The AG-Zero project is a new business model consisting of three key elements. First, it consists of eliminating or keeping to a strict minimum direct contact with respondents by using alternative sources of information, satellite images and models to fulfill the information needs. Second, this project also targets the leveraging of corporate

investments in new leading edge methods through the different statistical processes. And finally, this project is about building solid partnerships with data providers and data users to ensure their long term engagement toward the Agriculture Statistics Program. The Census of Agriculture 2021 is in transition toward this new model. The new approach is expected to be implemented by 2026. The article will describe the various initiatives that are implemented in regards to the three elements of the AG-Zero project through the statistical processes for the 2021 cycle. The changes will support the production of high quality data in a cost efficient manner. The use of multiple alternative sources of information will be used in the next Census of Agriculture to populate between 20% and 25% of the questionnaire content. The introduction of a ‘ collect-once-use-multiple times’ strategy at the government / industry level leads not only to having a set of variables that will be compiled from alternative data sources only, but also to the customization of the electronic questionnaire for each operation based on the presence or absence of alternative sources of data for this operation. Statistics Canada will continue to optimize the user experience with the electronic questionnaire and keep to a strict minimum the use of the costly paper collection mode. The use of the electronic questionnaire as primary mode of collection has been an important source of savings in the 2016 cycle. The migration of the Census of Agriculture program to the Integrated Business Statistics Program (used for 130 business programs) and its harmonized leading edge methods, systems and tools opens a realm of opportunities to leverage the corporate investments in new advanced methods such as machine learning or advanced disclosure avoidance techniques, without the development of costly local solutions. Finally, the strategic development of long standing partnerships with key stakeholders is an essential step in the project plan for the sharing of the data and expertise required to achieve the goal of conducting a Census of Agriculture with only minimal contact with farmers in 2026. These innovations should not only help fulfilling the current information needs in an efficient way but are crucial to advantageously position the Census of Agriculture to meet the quickly evolving needs of the future in a cost efficient manner.

T2.3.5: Using mobile data collection as a catalyst in linking population and housing censuses with agricultural censuses and reducing costs (Abstract Id: A2-2-021)

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The call to “Leave No One Behind” in the 2030 Agenda for Sustainable Development and its Goals (SDGs) elevates the importance of and need for reliable data. Achieving the SDGs will require informed choices about priorities and strategies, for which high-quality official statistics are necessary. Yet, funding for strengthening official statistics in developing countries falls far short of what is needed - accounting for only 0.33% of all official development assistance. Producing the high-quality official statistics necessary for SDG reporting rests on the key pillars of a National Statistical System: the Population and Housing Census and the Agricultural Census. Both are large and expensive exercises, with the former often recognized as the largest peacetime operation a nation undertakes. This paper revisits the FAO and UNFPA recommendations for linking Population and Housing Censuses with Agricultural Censuses and proposes that innovations in data collection technologies can facilitate this linkage in certain contexts and can dramatically reduce the overall costs associated with both data collection exercises. Specifically, we explore how including simple screener questions during a Computer Assisted Personal Interviewing (CAPI) Population and Housing Census – whether the household is engaged in any form of own-account agricultural production and the area of land (or number of plots) used for agricultural purposes – can automatically generate the frame for the Agricultural Census. We present the benefits and challenges of various implementations of the linked census approach, including fielding both censuses simultaneously and conducting the Agricultural Census immediately following the Population and Housing Census.

Finally, we argue that National Statistical Offices, donors, and technical assistance providers should seriously consider the benefits of linking these two censuses as an efficient cost-saving approach during this period of increased demand for official statistics for SDG reporting.

Session T2.4: Role of Surveys in Producing Official Statistics

T2.4.1: Using all data sources to produce agricultural statistics: What does that mean for surveys? (Abstract Id: A2-2-035)

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To fulfill its mission of providing timely and accurate statistics in service of US agriculture, the United States Department of Agriculture's National Agricultural Statistics Service (NASS) conducts more than a hundred national surveys each year. Since the 1960s, the foundation of these surveys has been probability samples. As is the case with other Federal agencies, NASS has experienced increasing undercoverage of its list frame and nonresponse to its surveys in recent years. Further, with the increasing concentration of agriculture, respondents, some of whom may be contacted more than 20 times during a calendar year, are expressing concerns about the reporting burden. To address these issues, NASS is re-evaluating its processes. Efforts have been made to improve the current methods, including alternative methods of evaluating coverage and reducing nonresponse. Web questionnaires with responsive designs have been developed. Administrative data and previously reported data that can be used to reduce burden are being identified and evaluated. Currently, NASS has a strong remote sensing program that informs its estimation process. The integration of survey data, remote sensing data, and administrative data is being explored. Once this is accomplished NASS can then evaluate the relevance of each of its surveys to determine whether they can either be reduced in length or eliminated. This presentation considers the path NASS is on and explores the future of survey data within the Agency.

T2.4.2: Using new information sources for agricultural statistics -European Statistical System experience (Abstract Id: A2-2-028)

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A recent evaluation of the European Agricultural Statistics System (EASS) showed that the statistics could be produced more efficiently if the legislation would be adapted so that various sources of information could be used and if Member States would adapt to modern technology. The costs for agricultural statistics are high, but the burden/cost are considered appropriate when taking into account the substantial budget of the EU Common Agricultural Policy, and its impact on the economic situation in agriculture, including on the individual farms. However, the burden of providing data is perceived high because data needs are increasing, the data is still collected multiple times for different purposes, , and resources continue to shrink at EU and national level. European legislation on agricultural statistics is therefore being adapted to allow the use of any data source that fulfils the necessary quality requirements. Typically, the legislation states that one or more of the following sources or methods shall be used:

statistical surveys, [specific] administrative data sources, or other sources, methods or innovative approaches. Eurostat will soon be able to report the planned uptake of new methods for the 2020 agricultural census. So far the main alternative source for data is the administrative registers under the common agricultural policy that is increasingly used, strongly supported by farmers' organisations. In addition, under the assumption that very small agricultural holdings are more homogenuous than bigger ones, the thresholds for the part of the farms to be covered in a census or other structural data collections was raised. Countries need to provide data on the smallest units only if the area cultivated or livestock raised are more than 2% of the national total, and then only as a sample and only every 10 years. The main direct costs for national statistical authorities for the new approach relate mainly to the adaptation to new statistical, organisational and technical systems. In the mid to long term, these costs and burdens are expected to pay for themselves by a slightly lower burden, and more effective and efficient data production. Only the raised thresholds are estimated to represent about 18% savings in agricultural census years (or 56 million of 320 million Euro total costs, if applied to the year 2010), and comparative proportions for sample survey years. Short-term adaptation costs are estimated at around 8% of total costs. Eurostat will be able to show more detailed information on the costs by autumn 2019.

T2.4.3: Collection of farm gate prices through surveys in Kenya (Abstract Id: A2-2-033)

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The agriculture sector is a key determinant of Kenya's economic performance in any given year. Comprising about one quarter of domestic output, agricultural production and prices are major components in the data requirements for the compilation of national accounts. Consequently, the accuracy and completeness of agriculture sector statistics has a significant bearing on the quality of key economic indicators including the Gross Domestic Product (GDP). In computing the GDP, agriculture value-added is obtained by estimating the difference between value of total agricultural output and total inputs utilized within the production systems. The computation of Agriculture Value added in real terms requires that Agriculture Value Added is deflated by a suitable index such as Agriculture Producer Price Index as recommended in the 2008 System of National Accounts. The current practice is to use the consumer price index. While data on wholesale and retail prices is collected on a regular basis, there has been no attempt to collect farm gate price data in the past. Collection of this type of data would therefore address a critical data gap within National Statistics System. The Kenya National Bureau of Statistics (KNBS) has embarked on an Agriculture Producer Price Survey (APPS) which is meant to collect farm gate prices at the farm level. The data collected will include farm gate prices paid for agriculture output as well as prices paid for agriculture inputs purchased by agricultural households. Market retail and whole sale prices will not be collected in this survey since they are collected as part of regular market monitoring by the KNBS and the Ministry of Agriculture and Irrigation. The objectives of the APPS are to provide information that will be used in the valuation of the Agriculture GDP in real terms, develop an Agriculture Producer Price Index, compute the Agriculture Terms of Trade index and generally respond to users' data request. The APPS is targeting sampled households countrywide. Agricultural establishments will not be included but will be covered later in the year when a Census of Commercial Farms and Green Houses (CCF&GH) is conducted. The Agriculture Producer Price Survey module will be as part of the ongoing Kenya Continuous Household Survey Programme (KCHSP). Besides collecting agricultural data, is also geared towards producing poverty indicators at the national and sub-national levels; and labour. The KCHSP data once compiled will lead to more accurate estimates on Agriculture Value Added and hence the Gross Domestic Product (GDP) - the most frequently quoted indicator of economic performance. The data will also be available at the county level and hence useful for planning at the county (sub-national) level.

T2.4.4: Surveys and registers: On a pacific coexistence perspective for improving agricultural Statistics
(Abstract Id: A2-2-025)

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Important indicators of living conditions of the population, such as gross domestic product, human development index and sustainable development indicators, still depend on improving statistics to be properly monitored. Traditional ways of producing statistics, such as Census and Surveys, are effective but costly for producers, respondents and users. Related costs include data collection budget, respondent burden and loss of quality when operation size increases or must be conducted under budget restriction. Use of Registers are comparatively less expensive as it is already set up for administrative purposes, but not completely free of cost. Quality statistics depend on availability of perennial data sources, effective access to data, setting a method for data integration up and being prepared for making correspondent adjustments when using integrated data to avoid potentially misleading analyses. Meeting all those conditions are usually not straight forward. In that context, neither surveys nor registers can be considered best regardless the conditions and therefore they are not concurrent. They can even be considered complementary and, not rarely, somehow dependent on each other. Therefore, there is a coexistence perspective. Issues related to the use of surveys and registers in a combined way to improve agricultural statistics will be approached. To illustrate, an integrated system based on the use of surveys and registers which is being set up at Brazilian Institute of Geography and Statistics – IBGE to enhance agricultural statistics production will be presented.

Session T2.5: Building a Systematic Approach to Agricultural Statistics

T2.5.1: The Belize Agriculture Information Management System- Collection, Storage, Analysis, Reports Agriculture Statistics
(Abstract Id: A2-2-006)

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It is an established fact however that the agriculture sector data in Belize is lacking in coverage, quality and timeliness. The current system for collecting agricultural data, which is then used to inform the country's National System of Accounts, is based on expert opinion with an emphasis on large farming operations. Intuitively absent from this accounting then are the medium and small enterprises, not to mention the informal sector. The government has taken a policy decision to address the challenges being experienced by the sector. The Ministry's draft National Agriculture and Food Policy (NAFP) has identified statistics as essential for evidence-based policy making and critical to the implementation, monitoring agricultural production, processing, trade, food security and nutrition. To address the data quality challenge being mentioned, the Inter- American Development Bank (IDB) and the Ministry of Agriculture accomplished a project in December 2017. The outputs included that of an In-depth Country Assessment on Agriculture Statistics, and a Strategic Plan for Agriculture and Rural Statistics following FAO standards. The IDB also supported the development of statistical infrastructure (the Belize Agriculture Information Management System (BAIMS) which is a web based application that serves as the tool to register farmer, farm and production. The plan recommends the implementation of an Agriculture Census inclusive of continuous periodic commodity production surveys. The Ministry

decided to commence a phase of this activity by first developing a list frame by registering all farmers and testing the productions surveys already existent in BAIMS. The objective of the project was to populate the Farmer and Farm registry that contains farmer information and Geo referenced coordinates of their farm/s. The last Agriculture Census implemented in 2010/2011 had no geo-referencing of the farms. Using the technology now available, the geo referenced data will allow the Ministry to do remote sensing to forecast production, pest and disease surveillance, drainage and irrigation planning, and project weather effects to farms. The first phase that was conducted in one of the districts will Register all farmers and will be used to test the methodology and surveys that will be used for the collection of production data from all registered farmers. This will include the questionnaires, data collection methods, the training program for field staff, the instruction manual, data editing, coding, data processing and data tabulation. The first phase of the Registration and survey testing will ensure that critical issues and problems encountered during the field testing are corrected. The intention of the Government is to participate in the 2020 Agriculture Census supported by the FAO.

T2.5.2: Agriculture and rural development statistics in Nepal (Abstract Id: A2-2-020)

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The Agriculture statistics, conventionally, revolves around crop and livestock statistics. Eighty three percent of the total population of Nepal lives in rural areas and mostly relies directly or indirectly on agriculture as its principal means of livelihood. Agriculture has been playing a significant role in the Nepalese economy for a long time. Agriculture along with fisheries and forestry accounts for one-third of the nation's Gross Domestic Product (GDP). The reliable and timely available statistics is the back bone of developmental process not only for policy formulation but also for implementation, monitoring and evaluation of effectiveness of agriculture policies. In the 21st century, agriculture and rural development statistics have been extensively used for environmental and sustainable development, food security and poverty alleviation, monitoring SDG and gender equity. This paper will explore on arrangements for the collection of agriculture and rural development statistics to meet policy, monitoring and evaluation of agriculture related development plans. Rural development in Nepal is a multidimensional aspect involving an interaction of economic, social, political and cultural factors. The concept of rural development is the process of improving the quality of life and economic well-being of people living in rural areas. Agriculture is still at the core of the rural economy particularly on poverty reduction. The policies and programmes have been designed to reduce rural poverty for a long time which has been one of the primary objectives of planned document. Presently, Nepal's agricultural and rural development statistics are somewhat limited and sometimes the data obtained from different sources differ widely. Agriculture and rural development statistics are collected through Central Bureau of Statistics (CBS) and Ministry of Agricultural and Livestock Development (MoAD). The objective of this paper is to help readers identify the data producer, the key sources of information, along with the strengths and weaknesses of agriculture statistical system in Nepal. In order to cater to the growing demand of high quality and reliable agriculture statistics, responsible agencies need to forge better harmonization and work collectively to enhance the overall agriculture statistical system. Agriculture Integrated Survey (AGRIS), the ongoing project in CBS, could be instrumental for the continuous supply of Agriculture and Rural Development Statistics in the days to come.

T2.5.3: An appraisal of fisheries data collection systems in Malawi (Abstract Id: A2-2-017)

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Malawi uses two data collection systems namely Catch Assessment Survey (CAS) and Malawi Traditional Fisheries (MTF) on small scale fishery and catch returns data on large scale fishery. Data collection of small-scale fisheries is cumbersome due to their dynamism, lack of institution resources and varying fishing gears employed. 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. 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 minimise errors that CAS make. A study was done to appraise both small scale and largescale fisheries data collection systems 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. Standards, procedures and guidelines on sampling, data analysis and reporting need to be developed/improved and enforced. There is a need to ensure that the data is well managed by statisticians by profession. Field staff needs to undergo refreshers courses on data collection and fish taxonomy regularly. The link between research and extension arms of Department of Fisheries needs to be strengthen. Instead of Department of Fisheries, annual frame survey should be conducted by or in collaboration with National Statistics Office to improve on the quality of the data as precision, accuracy, frequency, timing, usefulness, and cost- efficiency of the survey have often been questioned. This is due to lack of proper data validation, cross-checking and generation of false data among others. 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 seldomly supervised data collection system.

T2.5.4: Use of satellite data in agricultural statistics in Poland (Abstract Id: A2-2-016)

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In recent years, Copernicus program, launched by the European Union, provided the free access to daily updated inventories of high resolution data. The satellites of Sentinel series, numbered S1, S2 and S3, deliver multiple data sets each 4-5 days with the 10 – 20 m (300 m for S3) spatial resolution throughout the whole globe. The above mentioned data can be employed to recognize and monitor crops as well as

estimate yields or detect potentially hazardous weather conditions i.e. drought, floods , frosts. The vast inventories of satellite data become the challenge to statistical systems especially in transforming them to high quality statistics. Potentially, availability of such massive data source can lead to reduce respondent burden and obtaining statistics faster and on the lower aggregation level. Since the beginning of the Sentinel mission, Statistics Poland started thorough work on building agricultural statistics using satellite data. Images in time series were processed and classified according to crop areas and weather conditions. The classification method based on use of machine learning. In situ data collection and administrative data (The Land Parcel Identification System) provided necessary information for training of the system and the result quality assessment. The whole process included several steps such as satellite data acquisition, preprocessing (segmentation, delimitation of objects with uniform areas), classification and validation, generalization for territorial units. The major crops (cereals, maize, rape, potato, orchards, sugar beets, grasslands), which cover 90% of agricultural area were included. The obtained accuracy of crop recognition reaches up to 96%. The projects have been carried out by the Agriculture Department of Statistics Poland in cooperation with the Space Research Centre Polish Academy of Science, Institute of Geodesy and Cartography, European Space Agency.

Session T2.6: Remote Sensing (1)

T2.6.1: Use of satellite remote sensing for improvement of agricultural statistics in India (Abstract Id: A2-3-032)

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India is an agrarian country. Hence, accurate statistics of agriculture is essential for the economic planning of the country. India has a strong system of collection of agricultural statistics, through well-defined surveys and field experiments. Among various aspects of agricultural statistics, area, production and yield (APY) estimation is a major component. While area is estimated through complete enumeration or sample surveys, yield is estimated by conducting large number (around 1.12 million) of crop cutting experiments (CCE). Ministry of Agriculture releases four advance estimates and the final estimate for APY. However, collection of these APY statistics is highly labour oriented, costly, time consuming and also prone to human bias. In order to improve timeliness and accuracy of the crop estimates, Ministry of Agriculture, in 2007, launched a national level scheme, called FASAL (Forecasting Agricultural output using Space, Agro-meteorology and Land based observations), which involved econometric, agro-meteorological and remote sensing based approaches for pre-harvest crop production forecasting for 11 major crops of the country. In 2012, Agriculture Ministry established a specialized centre (Mahalanobis National Crop Forecast Centre) to operationalize the remote sensing based crop production forecast, by using technology developed at Indian Space Research Organization (ISRO). Currently, remote sensing based multiple pre-harvest crop production forecasts are being generated for 8 major crops (Rice, Wheat, Cotton, Sugarcane, Rapeseed & Mustard, Rabi Sorghum, Rabi Pulses and Jute), at district-state-national level. The crop area is estimated using optical (Resourcesat 2 LISS III & AWiFS, Sentinel 2 MSI & Landsat 8 OLI) and microwave (Risat 1, Sentinel 1 & Radarsat 2) remote sensing data, while yield is estimated using empirical models (based on weather and remote sensing parameters), semi-physical models, crop simulation models and selected CCEs, whose locations are proposed based on remote sensing data. Around 10000 Ground Truth points, collected every year, using Smartphone based Android App, are used for crop classification The FASAL estimates and outputs (crop maps) are not only used for refining the government estimates, but also for many other purposes including crop insurance, disaster impact assessment, infrastructure planning, crop intensification, decision support system, etc. Based on

the success of FASAL project, government, in 2014, launched a new programme called CHAMAN (Coordinated Horticulture Assessment and Management using geoiNformatics) to generate remote sensing based area and production estimates for 7 major horticultural crops (Potato, Onion, Tomato, Chilli, Mango, Banana and Citrus). During the Phase I (2014-2018), technology was developed, in collaboration with ISRO, for satellite based assessment of these crops. During, Phase II (2018 onwards), operational estimates are being generated for these 7 crops in 263 districts of 15 states. Both FASAL and CHAMAN programmes have large number of (>100) implementation partners, which include national organizations, state agriculture and horticulture departments, state remote sensing centers and agricultural universities. This presentation will discuss the different components of FASAL and CHAMAN programmes, including approaches, results, accuracies, limitations and future pans.

T2.6.2: Agricultural statistics transformation based on remote sensing data for administrative and sustainable development goals purposes (Abstract Id: A2-3-011)

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The new era of remote sensing exploitation started with the launch of Sentinel-1 satellites in 2014 and Sentinel-2 satellites in 2015. Sentinel-1 mission provide users SAR (radar) dual-polarized imagery (VV/VH – vertical and orthogonal), free of charge, with unprecedented revisit interval of a few days over very large swaths at satisfying geometric resolution of about 20m (depending on the mode of acquisition) while Sentinel-2 (optical) mission provide high resolution, multispectral, wide-swath, free of charge remote sensing data. The presentation will present the results of Sentinel- 1 SAR sensing data processing and the Sentinel-2 multispectral in order to obtain correctly classified agricultural crops for statistical purposes. Satellite data in combination with in-situ field survey provide a comprehensive opportunity to monitor, evaluate and forecast changes in the natural environment. It can be noted that the purpose of these studies is convergent with the implementation of SDG goals such as counteracting the loss of biodiversity, protection of extensive water ecosystems, or the implementation of actions in agriculture to protect such ecosystems within the agricultural areas. An example here is Goal 2 - End hunger, achieve food security and improved nutrition and promote sustainable agriculture – indicator 2.4.1, within which it is possible to show the level of application of practices supporting biological biodiversity (ecosystems) at farm level. Based on administrative data, Geographical Information Services (GIS), combined environmental monitoring systems and remote sensing of agricultural land, it is possible to implement practices that help to adapt to climate change, extreme weather events, drought, floods and other disasters, and gradually improve soil quality through responsible sustainable agricultural management (Common Agricultural Policy). It is very important, mentioning indicator 2.4.1, that its intention is to focus on a farm level assessment of sustainable agriculture, rather than provide information to support a more generalized discussion on the contribution of agricultural activity to various economic, environmental and social outcomes. The presented approach will describe the possibilities and results of crop recognition in combination with administrative data and the Big Data from satellite observations, allowing to take a new look at the role of statistics and its possible transformations, while in the same time increasing the precision of real results that can be directly used in SDG goals implementation. Cooperation with the European Space Agency will also be presented, involving the extension of currently defined algorithms (toolbox) not only for crop recognition modules but also for ongoing monitoring of plant condition, vegetation status and yield forecasting.

T2.6.3: Beyond NDVI: Impact of distribution characteristics of alternative remotely-sensed data on county maize yield estimates (Abstract Id: A2-3-025)

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The United States Department of Agriculture's (USDA's) National Agricultural Statistics Service (NASS) uses a remote sensing process for modeling regional yield averages for U.S. maize based on multispectral satellite imagery acquired by the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor. Red and near-infrared (NIR) light reflectance imagery is used to calculate the Normalized Difference Vegetation Index (NDVI) as a biomass indicator. This results in a dataset of 250m2 pixels geographically covering the U.S., where each pixel contains an NDVI value. These pixel-level NDVI values are then averaged at the regional level for modeling purposes. However, these regional averages ignore information about the statistical distribution of the pixel-level NDVI quantities that could provide further insight about the natural and agricultural processes that impact maize yield. Another factor impacting yield estimation is the tendency of NDVI to saturate in regions with dense plant canopies. U.S. maize production has continually seen technological advances that allow for denser planting of highly productive maize plants. This trend may weaken the functional relationship of NDVI with maize yields in high productivity areas. Other vegetation indices have been developed in response to NDVI saturation issues, particularly the Two-Band Enhanced Vegetation Index (EVI2). Finally, although using a vegetation index (VI) like NDVI or EVI2 provides an intuitive understanding of plant biomass and reduces the size of datasets, it sacrifices some of the original information found in the raw red and NIR reflectance data. Improved computing power and machine learning techniques allows for individual red and NIR reflectance data to be used in yield models without reducing them into VIs. The goal of this research was to explore techniques to improve precision of county-level maize yield estimates by combining two approaches. First, the usefulness of NDVI, EVI2, and reflectance data as predictors of county maize yields was explored. Second, measures of central tendency and dispersion of the pixel-level NDVI, EVI2, red, and NIR data were calculated to provide a more complete representation of the statistical distribution of these data at the county level. A rule-based, decision tree model was used to estimate county yields under different variable input scenarios. Results demonstrated that including standard deviation of county pixel data and replacing NDVI with either EVI2 or reflectance data improved the model. Model performance was evaluated across all counties in the U.S. "Corn Belt" in terms of variable importance, relative error of the model, and Root Mean Square Error of the predicted 2018 county yields.

Session T2.7: Remote Sensing (2)

T2.7.1: Integrating earth observations into feed the future to enhance programmatic decisionmaking, monitoring and evaluation in the US government's global hunger & food security initiative (Abstract Id: A2-3-020)

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As the lead Agency for Feed the Future, the US Government's global hunger and food security initiative, USAID's Bureau for Food Security recognizes the need to incorporate Earth observations (EO) data throughout our program cycle as a critical element of monitoring progress toward achieving Feed the Future's key results, as well as the Sustainable Development Goals. Our vision is that these data should be incorporated into program design, and into decisionmaking about where and what kinds of activities we design and implement. Satellite imagery should be used during project implementation to support remote activity management, supervision, and adaptation. Because Feed the Future activities are likely to result in changes across landscapes as farmers, pastoralists and fisher folks carry out measures to improve agricultural productivity, EO data should be used to monitor the progress of interventions designed to diversify crops and livestock systems, expand irrigation, manage land more strategically, improve soil and water management, and conserve biodiversity. USAID also wants to support our partners to access and use these data to manage their own programs and policies. This paper describes the steps that USAID's Bureau for Food Security have taken over the past two years toward realizing this expansive and ambitious vision, and our lessons learned. Constraints to rapid achievement of goals in this regard include technical capacity limitations within the Agency, while opportunities to make progress on this front have materialized through mutually beneficial collaborations with expert colleagues both inside and outside of USAID. By sharing our experiences as we work to strategically incorporate these critical data and related analytical products into our workstreams, we hope to broaden the conversation and learn from others who are working towards the same objectives.

T2.7.2: Satellite-derived services for a sustainable and productive agriculture (Abstract Id: A2-3-010)

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Many trends are pressuring farmers: population to feed is rapidly increasing, agricultural land is limited by urbanization and forest protection. Governments need to manage food supply and assess adequately import/export, because of commodity price volatility. This calls for dramatic yield increase and intensive use of chemicals. Increasing agriculture productivity while preserving the environment and optimizing the resources are at stake in agricultural policies. Governments need data to monitor crop growth and production: - Manage national food supply more effectively, - Optimize the resource use (land, fertilizer, water) for increased productivity while respecting environment, - Decide support programs, d) Support farmers on best farming practices to increase productivity and resilience to climate change. Space monitoring has become a truly cost-effective option for crop monitoring. Satellite imagery allows improving agricultural information systems with relevant insights in terms of accuracy and timeliness,

with geospatial vision. Satellite imagery is now embedded in agronomic portals. Today we are flooded by high quality data and much of it is for free. But while the mass of data increase, the main challenge persists: how to transform this data into meaningful information for agricultural authorities? Satellite-derived insights improve national agricultural information systems and support governments in their decision process to increase agricultural productivity and resilience to climate change, while respecting the environment. Building on more than 20 years of R&D, Airbus has developed advanced analytics to analyze crop types, agricultural practices, crop development and production estimates – automatically, over millions of parcels, and in real time. Airbus online services are giving access to satellite-derived biophysical parameters such as Green Cover Fraction (fCover), Leaf Area Index (LAI) or Chlorophyll for major crops such as wheat, rapeseed, barley, corn, soybean, almonds, potatoes, cotton, sunflower, sugarbeet, rice, sugar cane, alfalfa, grass. By combining these vegetation indicators with some extra information (such as type of crop, sowing date, crop model, or field boundaries…), one can obtain agronomic information (biomass quantity or nitrogen status), or even derive farming recommendation (such as the quantity of nitrogen to spray, for instance). This unique know how opens access to biomass and nitrogen content in an industrial manner, out of any satellite or UAV imagery, without any ground measurements. These advanced analytics are fully comparable over time and geographies. Thanks to this cutting-edge technology, Airbus supports the whole agricultural value-chain down to farmers.

T2.7.3: Using deep convolutional network on remote sensing data for crop area estimation to improve the quality of statistical agricultural data in Indonesia: a case study of paddy fields in Indonesia (Abstract Id: A2-3-024)

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The agricultural sector, especially the rice commodity, still prevails as the core of economic growth in Indonesia. As the most important staple crop in Indonesia, rice has a strong influence on both the economic and political sectors. However, over the last two decades, the rice production data in Indonesia has suffered from the inaccuracy issue due to the weaknesses in the harvested area measurements. This situation could adversely affect the policies making, especially the policies that are designated to achieve food resilience and self-sufficiency. To tackle this challenge, since 2018, BPS-Statistics Indonesia has tried to refine its methodology by implementing the Area Sampling Frame (ASF) approach to generate a more precise harvested area estimation. ASF is carried out in 2 steps: (1) the establishment of a sampling frame in the form of stratification and segmentation of the land into grids, and (2) the field survey to observe the growth phase of paddy. The first step involves the use of administration map, land cover map, as well as satellite imagery to detect and obtain paddy field area information. Nevertheless, there is a hidden critical issue in the first phase of ASF implementation. The land types classification is performed manually using ‘eye estimate method and subject to wrong identification due to human eyes limitation in distinguishing paddy field from other types of land cover. Moreover, the sample frame cannot immediately accommodate the recent changes in land use. These shortcomings could cause wrong segmentation, which will lead to inaccuracy rice production data. In this paper, we try to study a new approach for land types classification using deep learning method. We propose the use of a deep convolutional network to conduct visual recognition and classification tasks. First, we prepare the training data by augmenting it (shifting, rotation, zoom) to increase the number of training data. Second, we modify and train the U-Net model to classify the land cover into the paddy field, non-paddy field, and non-agricultural area. Third, we deploy and run the model. The accuracy assessment will be conducted by calculating the precision and recall for each land cover class. We will also show the sample of color-masked images indicating the class. The development and assessment of this approach are ongoing using

Python, Keras, and ArcGIS API. We hope this preliminary study could help improving rice production data quality in Indonesia as well as serving as a benchmark for other food crops such as maize and soybean.

T2.7.4: Reviewing the cost-efficiency of satellite images for the estimation of crop areas in western Europe: A case study in Castile and Leòn (Spain) (Abstract Id: A2-3-005)

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The estimation of crop areas has been one of the first targets of Earth Observation (EO) from satellites. The first naïf approach to estimate areas by simple pixel counting was soon substituted with more consistent approaches combining field observations with classified images Pixel counting remains acceptable in some cases, such as crops in large fields with very low omission and commission errors or zones where field surveys are nearly impossible. This paper does not analyze the different approaches to combine satellite images with field data to provide crop area estimators. Our purpose is rather assessing the cost-efficiency of the contribution of remote sensing to the area estimation, in particular for the regression estimator. In the US, the cost-efficiency threshold was reached in the early 90's. At that time cost-efficiency had not yet been achieved in the European Union. Tests around 2010 proved a positive cost-efficiency in Ukraine, where the dominant field size is much larger than in the EU. In this paper we have a look at a test case in central Spain, where the dominant plot size is approximately between 1 ha and 3 ha. The result is a very clear change of the situation: the relative efficiency of the regression estimator is around 3 for the most important crops, compared to values around 1.5 – 1.7 that were obtained in the 90's. On the other hand, the relative efficiency threshold for the method to be cost-efficient is now much lower than it used to be 25 years ago, so that the positive conclusion would comfortably hold with a relatively large change in the conditions. Moreover crop maps have an interest that goes beyond their use as ancillary data to improve crop area estimation. In particular for the purpose of agri- environmental indicators classified images (possibly combined with field data) are useful to study the spatial interaction between the agricultural activity and natural vegetation, water courses and associated vegetation buffers, etc. The main reasons for the cost-efficiency improvement are: • Free data distribution policy by major Earth Observation satellite owners. • Availability of a larger number of sensors providing images with a resolution of 10-30 m and swath wider than 100 km, as well as improvement of other characteristics of images (number of spectral bands, geometric stability); Reduction of computing costs: friendlier software, cheaper and more powerful hardware. However, there are some limitations on the extent of the conclusions: The results might significantly change in landscapes dominated by very small plots where the proportion of pixels on the boundaries (mixed pixels) is high; For this study we reduced the nomenclature to 20 classes, grouping minor crops. The cost-efficiency is less clear for crops with a very low area, but economically important; Our benchmark for the comparison was the extrapolation of a stratified area frame with a large sample of segments and a relatively coarse stratification. The results might change with a different benchmark, although it is unlikely that the positive conclusion is turned upside down.

Session T2.8: Technologies for Data Collection

T2.8.1: Adapting CAPI to national surveys: Quantifying the effects versus PAPI using Sri Lanka's agricultural household survey (Abstract Id: A2-3-012)

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The link between agriculture and poverty reduction is a topic that has been around several years. In the Asia and the Pacific alone, more than 60% of the labor force relies on agriculture as its main source of livelihood. Given its recognition, it became a part of the Sustainable Development Goal (SDGs). It is measured through agricultural statistics from the conduct of Agricultural Household Surveys. In most countries, these are collected by pen-and-paper interviewing (PAPI) technique. In the past few years, the advent of technology has led to developments in data collection, which includes Computer Assisted Personal Interviewing (CAPI). Using a hand-held device, CAPI eliminates the burden of encoding, manual validation, and missingness on the data, that leads to better data quality and improve timeliness. While these perceived benefits are attractive, it is still unclear to what extent this affects the estimates in data analysis. This paper presents the results from a randomized experiment designed specifically to compare CAPI and PAPI using data from the first Agricultural Household Survey of Sri Lanka during the Maha Season from January to June of 2017 focusing on the Anuradapura district. Within each of the 191 primary sampling units, 10 housing units were randomly selected and interviewed using PAPI, while another 10 housing units were randomly selected and interviewed using CAPI. This design allowed for a detailed comparison of errors, interview times, and costs between the two methods. In addition, we test the hypothesis whether these errors are non- random, which may lead to differences in estimates for agricultural statistics between the two groups.

T2.8.2: CSPro android implementations in African population and housing censuses: Observed opportunities and challenges for agricultural censuses (Abstract Id: A2-3-008)

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Recent expansion in mobile connectivity and progress in technological innovations (such as cloud computing, smart mobile devices, global positioning systems (GPS), and use of satellite imagery) have provided new opportunities for National Statistical Offices (NSOs) in conducting Population and Housing Censuses. Many African NSOs are at the forefront of adopting these new technologies in the 2020 round of Population and Housing Censuses, replacing paper questionnaires with electronic ones. Observed benefits include reduced data collection and processing time, enhanced and prompt feedback between enumerators and the central backstop team, and improved data quality. However, this transition also carries with it some unique challenges, such as equipment cost and care, device-specific user training, and data security. The US Census Bureau's International Programs (IP) has developed a number of public domain tools and provided capacity-strengthening training to NSOs around the world in the implementation of Computer-Assisted Personal Interviewing (CAPI) Population and Housing Censuses. The group's flagship product, CSPro Android, has been used to enumerate over a quarter of a billion people in censuses since its release in 2016. Drawing on IP's extensive involvement in assisting African

NSOs implement CAPI censuses, this presentation examines experiences with the use of CSPro Android during the 2020 round of Population and Housing Censuses on the continent and highlights how these experiences can be leveraged to enhance efficiencies and improve the quality of Agricultural Census operations and data.

T2.8.3: Improving Cassava Production and Productivity Measurement: Lessons from an Experiment in Zanzibar, Tanzania (Abstract Id: A2-3-002)

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Like in many Sub-Saharan African countries, Cassava is a major staple crop Zanzibar. Because of its drought tolerance, cassava is also a key crop for food security. Accurate harvest production and yield measurements are therefore critical but challenging for recall-based surveys in practice. Cassava is harvested over extended periods of time, of variable length, frequency, and amounts, often spanning across agricultural seasons. The need of area measurement for yield estimates further compounds these issues, as self-reported land area is known to contain measurement error. Zanzibar's Ministry of Agriculture, National Resources, Livestock and Fisheries (MANRLF) in collaboration with the World Bank conducted a methodological experiment to shed light on such measurement error in recall surveys and improve Zanzibar's cassava production estimates. Over the course of 12 months, 1260 households were randomly assigned to one of four groups, each administered a different approach to collecting cassava harvest data: harvest diary-keeping, with agricultural extension officers visiting twice weekly (D1), diary-keeping with supervisor phone calls twice weekly (D2), 6-month recall in two visits (R1) in 12 months, 12-month recall in one visit (R2)in 12 months. In addition, crop cutting was implement on selected plots from all households, providing an objective comparison category. The analysis suggests that harvest diaries in conjunction with twice weekly phone monitoring (D2) is the most promising method of data collection for cassava, outperforming harvest diaries with twice weekly visits (D1). There are clear also benefits to reducing the recall period to 6 months (R1) relative to the standard 12 months recall (R2). Comparing cassava yields based on area measurement using self- reporting, compass-and-rope, and GPS further shows that estimates based on self-reporting are subject to significant measurement error. The findings of this paper, along with those from a similar experiment implemented in Malawi, fed into the recent Handbook on Crop Statistics: Improving Methods for Measuring Crop Area, Production and Yield published by the Global Strategy. This presentation of this paper will detail the experimental design, provide an in-depth understanding of the results, their drivers, and implication for cassava production and yield measurement and survey design.

T2.8.4: The use of technologies to improve the quality and the efficiency of the 2017-2019 fishers' census in Haiti (Abstract Id: A2-3-009)

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Haiti has 1,771 km of coastline and a marine fishery sector contributing to approximately 1.5% of its GDP. In coastal areas, this sector represents the main, and sometimes only source of livelihood for approximately 65,000 marine fishers and their families, despite the challenges that it is currently facing such as overfishing and environmental degradation. In this context, the absence of data on fisheries is restricting the capacity of the Government, and the Ministry of Agriculture (MARNDR) in particular, to design and implement appropriate policy responses. Since the end of 2017, the Statistics Unit from MARNDR (USAI) has been implementing a nationwide census of marine fishers using resources from an Inter-American Development Bank (IADB) grant. It is the first time that such an exhaustive data collection effort is conducted in this sector. This census has been designed in three phases, two of which have already been completed as of May 2019 (preliminary results can be accessed at www.haitistatagri.com). During Phase 1, USAI identified a total of 592 disembarkation points along the entire coastline of Haiti through a combination of satellite images analysis and field work. The former allowed USAI to elaborate a preliminary mapping of disembarkation points and fishing vessels density, which later facilitated the organization and implementation of the field work. USAI then organized focus groups in each of those 592 sites in order to collect community-level data on the fishery sector (Phase 2) and is currently in the process of administering individual questionnaires to the entire population of marine fishers (Phase 3). Phase 2 provided USAI with the opportunity to develop and fine tune its approach to use 3G tablets for data collection and quality controls, before scaling it up in Phase 3. Data collection speed and data entry reliability are the main expected benefits from using tablets in such large-scale data collection efforts. The GPS tracking function can also help ensure appropriate and exhaustive coverage of the survey area, while the access to real-time data can accelerate and streamline the production process of inconsistency reports. The challenge, however, resides in the organization of human resources, and in the establishment of clear and detailed procedures so as to ensure that these benefits can indeed be materialized. In order to succeed, USAI has set up a team of programmers and statisticians, based in the central office of Port-au-Prince and having direct access to real-time data, and whose role is to monitor field progresses and to produce daily consistency reports using tools such as CSPro and R. On the field, Surveyors work under the dual supervision of Supervisors, in charge mainly of logistics and dispatching, and Quality Controllers, who are responsible for implementing traditional on-the-field quality controls as well as ensuring the appropriate and timely treatment of inconsistency reports. In sum, this census has provided USAI with an opportunity to innovate through the use of new technologies such as satellite images and tablets, in an attempt to improve the quality, the efficiency but also the sustainability of its data collection activities.

T2.8.5: Mobile assisted personal interview software-filed experiences from implementation in crop estimation survey in India (Abstract Id: A2-3-007)

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The use of conventional method of data collection, i.e. Paper Assisted Personal Interviewing (PAPI) method has several inherent weaknesses such as non-sampling errors in collection, tabulation and processing of the data. This leads to problem in data quality and timeliness. To tackle this problem, an android based software named Mobile Assisted Personal Interview (MAPI) was developed by ICAR-Indian Agricultural Statistics Research Institute, New Delhi for collection of survey data using smart phones. The software was copyrighted under Indian copy right act with reg. no. SW-9378/2017 and has been implemented successfully in the agricultural survey conducted in the two states in India namely Uttar Pradesh and Gujarat. The results obtained from these surveys show that MAPI is efficient both in time and accuracy and emerges as an efficient alternative to PAPI.

Session T2.9: Frontier and Innovative Technologies

T2.9.1: Harvesting the potential of artificial intelligence / machine learning in agriculture - The need for a structural approach (Abstract Id: A3-5-027)

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As the population increases and incomes rise, demand for food will also grow. In a recent report published by the FAO's Jelle Bruinsma it is expected that total demand for agricultural products in 2030 will be about 60 percent higher than today. More than 85 percent of this additional demand will be in the developing countries, as nearly all population growth will be there. Although there is systemic progress in the potential to increase production, providing further boost to the agricultural development with modernization of Agriculture Technology, digital transformation with the application of artificial intelligence & machine learning has become an imperative for the human sustenance and achieving sustainability development goals. The emerging technologies Artificial Intelligence and Machine Learning are making many innovations possible in the field of agriculture. However there is a need to adopt a structured approach to deploy the AI based applications. We need understand to many aspects of AI / ML applications and its challenges. AI needs large volumes of data for its training and validation especially if we are undertaking image and video analytics for crop protection, agriculture produce assessment and assessing natural disaster impact. Not only the volume of data, but data quality is extremely important. For application of AI on image and video, conversation of images marking meaningful areas of interest and its meaning is critical. For faster processing, we also would need to deploy the AI / ML environment with high computing facility such as GPU, FPGA. Finally it is of utmost importance to implement a sound architecture (considering the potential of IoT, Advancement in Computing Infrastructure, Communication and Gateway Technologies, New Sensors) that can help maintain and update the AI / ML applications and ensuring the continuous learning and delivery. This paper highlights the digital transformation trends & various analytics use cases for digital agriculture

highlighting the application of AI / ML and process of deployment of the AI / ML applications considering image and video analytics. It also discusses a plausible end state architecture for Artificial Intelligence of Things, a blend of Artificial Intelligence and Internet of Things that can provide suitable acceleration to meet the growing demand on agriculture produce. The paper highlights the new analytics life cycle and the need of establishing the technology and the capacity to deploy and make operational the AI / ML applications in the Agriculture Innovation and Incubation Centers across the country designed for specific farmer needs.

T2.9.2: Can citizen science and smartphones help to improve market transparency along the food chain? Evidence from crowdsourced food prices in Nigeria (Abstract Id: A3-5-023)

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Agriculture is a main source of income in many African countries, but it lags behind its production potential due, among others, to imperfect distribution of market signals. Food expenditures are a relevant share of household income. Timely and accurate information on agricultural markets allows consumers and farmers to make informed decisions about consumption and production, leading to more efficient markets. In Africa, the increase in smartphone use gave rise to Citizen Science projects to collect and share data and to several examples of crowdsourcing of food price. Yet, their impact on market participants and performance has received less attention. This paper investigates the impact of increased price transparency focusing on price volatility and differences in price levels between agricultural commodity prices collected through crowdsourcing from spontaneous volunteers in Nigeria. It presents a smartphone-based approach and a toolkit to collect and disseminate reliable near real-time market prices and that have gone through a quality approach previously developed (Arbia et al., 2019) to overcome statistical issues related to crowdsourced data to produce reliable area price estimates. Crowdsourcing is implemented in a randomize quasi-experimental way to identify treatment groups who were offered a higher level of market transparency and a control group that was not subject to change in market transparency. This allows estimating the impacts on prices and markets of increased market transparency and highlights the potential of new methods for better spatial-temporal analyses of prices.

T2.9.3: Contrast set mining for disease identification (Abstract Id: A3-5-031)

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The interplay between computer science and agriculture has led to collection of huge amount of information in agricultural datasets. Deriving knowledge from these datasets has become more challenging and requires the application of new approaches. A fundamental task in data analysis is understanding the differences between several contrasting groups. Hence, the concept of mining contrast

sets came in existence which is conjunctions of attributes and values that differ meaningfully in their distribution across groups. STUCCO is a search algorithm for mining contrast sets in this regards. It uses a breadth-first search approach. Applicability of the algorithm has been explained with soybean dataset for identification of diseases from UCI repository. Soybean disease dataset contains 47 objects and 35 multi-valued variables characterizing diaporthe-stem-canker (D1), charcoal-rot (D2), rhizoctonia-root-rot (D3) and phytophthora-rot (D4) diseases. In initial data cleaning, attributes having unique value for all the variables were removed from the dataset. Reduced dataset then has 20 variables characterizing soybean diseases. In the first level, all 20 attributes were taken alone to check whether any of them comes under contrast set. It resulted in 25 contrast sets, among which 8 were most significant and can uniquely differentiate diseases with 100% accuracy: "Stem Canker = Above Second Node" & "Fruiting Bodies = Absent" uniquely differentiate diaporthe-stem-canker from others. "Precipitation < Normal", "Stem Canker = Absent", "Canker Lesion = Tan", "Initial Discoloration = Black" & "Sclerotia = Present" uniquely differentiate charcoal-rot from others. "Canker Lesion = Dark Brown-Black" uniquely differentiate phytophthora-rot from others. In the second level combination of all 20 attributes were taken as pair to check whether any of them comes under contrast set. 386 Contrast sets were obtained, which can differentiate all 4 diseases up to some extent. 37 contrast sets can uniquely differentiate diaporthe-stem-canker from others, among which 24 contrast sets can uniquely differentiate diaporthe-stem-canker from others with 100% accuracy. 77 contrast sets can uniquely differentiate charcoal-rot from others, among which 55 contrast sets can uniquely differentiate charcoal-rot from others with 100% accuracy. 23 contrast sets can uniquely differentiate rhizoctonia-root-rot from others, among which 5 contrast sets can uniquely differentiate rhizoctonia-root-rot from others with 100% accuracy and 5 contrast sets with 90% accuracy. 23 contrast sets can uniquely differentiate phytophthora-rot from others, among which 10 contrast sets can uniquely differentiate phytophthora-rot from others with 100% accuracy and 1 contrast sets with 94% accuracy. Hence we can infer that contrast set mining helps in feature selection as well as generation of patterns which is responsible for disease occurrence. Multiple patterns will be helpful in creation of knowledge base which is difficult to create manually.

T2.9.4: Leveraging the Potentials of Information and Communication Technologies in Agriculture (Abstract Id: A2-3-003)

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Technology based applications such as satellite-based field monitoring, embedded sensors on crops and fields for monitoring pest and diseases, smartphone based monitoring tools, applications for predictions on wind direction, fertilizer requirement notifications, GPS-enabled technologies, water management technologies and others are generating a huge amount of data could be used for better agriculture practices. In addition, data on soil health, water availability, and predictions on rainfall and precipitation make this data source highly useful to precision farming and subject of analytical and storage and communications technologies such as Cloud Computing, Big data, Machine Learning, The Internet of Things, and Web- based Software as a Service platform. Application Keeping in view future trends with respect to usage these technologies, this research paper is attempted to study the present status of application of these technologies in making data based decisions in the context of Indian agriculture research. The major focus is on the application of Machine Learning, Cloud Computing, and The Internet of Things in the context of applications precision farming for increasing the productivity, reducing degradation of soil, reducing the need for chemical fertilizers, and efficient water requirement.

T2.9.5: Smart sensor, artificial intelligence and statistical modelling based solution for smart Agriculture
(Abstract Id: A2-3-015)

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Our research work covers wide variety of methods and models associated with sensors, deep learning and statistical modelling for smart agriculture. Primary focus of our work is on bridging the gap and finding a relationship between emerging technologies and farmers. This smart, robust and portable product and solution would transform policy making government bodies and farmers to the next level of value creation. The live soil nutrient monitoring and management product would improve the quality of life of farmers in the developing countries. It will also provide right data at right time to state agriculture statistical department for economic reforms to enhance the Gross Domestic Product (GDP) of the country. On the science and engineering perspective, our work involves in the product design and it would provide an insight on state of the art sensors and communication technologies for future agriculture product and solutions. A sensor is unattended low cost battery operated device with limited computing, communicating and storage capabilities. Pure live parameters associated with soil, farming, weather condition, location and so on would provide an insight on coming out with novel statistical model for smart farming. Based on the multidimensional sensor parameters and good statistical model, we are able to design and implement a robust artificial intelligence system through deep learning technique for the farmers. This information is made available to the farmers' mobile in their native language with multimedia content. We strongly feel that the entire product and solution is the need of the hour. Working of the product and solutions: This product provides live measurement, monitoring, management and diagnostic of soil nutrients. Primary micro nutrients such as Nitrogen (N), Phosphorus(P) and Potassium(K) Secondary macronutrients Calcium, magnesium, and sulphur; micronutrients iron, manganese, zinc, copper, boron, chlorine and molybdenum;, conductivity, temperature, moisture, lux level, pH. In addition it will also provide live Global positioning system (GPS) location, and multimedia (text, audio, and video) of the soil testing location/farm. These information's are made available to view locally (mobile device/product display) or over cloud, or IoT or any other possible communications networks. Received parameters from various transducers are fed to novel software tool which would accurately determine the available nutrient status of soils and guide the efficient use of fertilizers. It's also possible that if a person/farmer sends an SMS or by pressing a button, then automatically he/she would receive the soil parameters of the mention farm/land. With the increasing awareness of fertilizer effects on environmental and soil quality, these live soil parameters are needed for efficient agricultural production, including site-specific crop management as per local requirements. All these parameters are made to available live at local or central or multi location by with or without any network via wired or wireless or satellite communication. Product brochure:
http://www.agenttech.org/Agenttech_LiveSoilNutrientMonitoring_SLiM.pdf
Product Video:
http://www.agenttech.org/Agenttech_LiveSoilNutrientMonitoring_SLiM.mp4
http://www.agenttech.org/Agenttech_Live_SoilNutrientParameterMeasurementAndMonitoring.pdf
http://www.agenttech.org/Agenttech_PrecSesnos_Agri_Products_Soil_Micronutrients_Presentation.pdf

T2.9.6: Agricultural data/ information dissemination & communication: Case of KALRO (Abstract Id: A3-5-026)

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Kenya is home to many private, regional and international agencies, making its agricultural research system one of the most diverse in Africa. Kenya Agricultural and Livestock Research Organization (KALRO) has been one of these agencies; has 16 institutes and 51 centers spread throughout the country. The mandate of KALRO is to undertake, streamline, coordinate and regulate all aspects of research in agriculture and livestock development, and promote the application of the research findings, technologies, and innovations for the wellbeing of Kenyans and various stakeholders. Being the premier agricultural and livestock research organization in Kenya, KALRO is obligated to provide demand-driven solutions to agricultural challenges locally, regionally and internationally through cutting-edge research. Thus, KALRO not only focuses on addressing national challenges but also lead globally through partnerships, collaboration, and networking to generate technology and innovations. KALRO guided by its Vision "Excellence in agricultural and livestock research towards transformed livelihoods"; and Mission "To conduct agricultural research through the application of science, technology, and innovation to catalyze sustainable growth and development in agriculture and livestock product value chains." Currently, KALRO has embarked on intensive ways of management, Dissemination, and Communication of data/ information to various stakeholders majorly targeting the small-holder farmers in Kenya. In-line with these, KALRO has developed over 33 Mobile Applications and 5 Online platforms for information management, Dissemination, and Communication. We've also developed an accurate weather forecasting platform called "Kenya Agricultural Observatory Platform – KAOP.Co. Ke" this platform is offering weather advisories for any location in Kenya. Users can search by County, Sub-county, Location, and Ward and retrieve weather forecasts for; Last 30 days, Last 7 Days and 7 Next days or by using the custom search that searches by the name of any location in Kenya. These innovations have transformed how agricultural information is disseminated at KALRO. These platforms seek to promote learning and increase the capabilities of stakeholders who include; farmers, policymakers, national agricultural extension Officers, research and academic institutions, relevant government institutions, development partners, private sector and NGOs amongst others. The data and information on the developed platforms have attracted interests locally and international. This paper reports on the use of ICT Innovations at Kenya`s premier research organization the Kenya Agricultural & Livestock Research Organization (KALRO) through enabling efficient and effective research data/information management, Dissemination through the development of knowledge platforms and mobile innovations. The paper argues that ICT Innovation in disseminating Agricultural information makes it easy for policymakers and other stakeholders make timely and effective decisions that would enhance food security.

Session T2.10: Administrative Data

T2.10.1: Agriculture routine data system in Tanzania (Abstract Id: A2-4-017)

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In Tanzania, the Ministry of Agriculture (MoA) and Ministry of Livestock and Fisheries (MLF) adopted the Agriculture Routine Data System (ARDS) to collect the administrative data by stationing enumerators

at the Villages, specifically to collect data on the areas cultivated, planted, harvested by type of crop, etc. This is in line with the data gap bridging initiatives, caused by the decentralization by devolution process in the country since 1970s immediately after independence, whereby power was entrusted to the sub national level (Masoi et el, 2009). This paper will discuss the key role played by routine data towards economic development in Tanzania. The routine data generated through day to day activities at the facility or project level, but have not followed any statistical procedure are called administrative data. In case of data generated through agricultural undertaken activities like the number of cows treated by the veterinary officers or number of crops produced, are collected by agricultural extension officers. Due to Decentralization by Devolution (D by D) policy, the planning starts at village level by the village committee, then goes to the Ward level, Local Government Authority and lastly at President's Office, Regional Administrative and Local Government. Therefore, the availability of data at these level for evidence-based planning, decision making and policy making as well as monitoring and evaluation of development projects which is very important can take place. In Tanzania, the Agricultural Routine Data System (ARDS), which is a web base system, was established since 2007 and the main object was to collect agricultural data from the village level by the trained extension officers with the aim of submitting them to the higher level mainly for the evidence-based planning, decision making, monitoring and evaluation purposes. Apart from the challenge of quality, many efforts have been taken by the implementing Institutions to enhance the quality within the production chain. In the absence of survey and census data, which are collected based on the statistical approach, the use of the administrative data as one of the sources of data, comes in and plays its part of gauging the economic development identified in country's development policies and programmes, like Tanzania vision 2025 and National Five-Year Development Plans. The plans are a pathway or as a bridge to achieve the vision's objectivities, which can be gauged through the available collected official data (Ministry of Finance and Planning, 2016). Routine data as one of the official sources, plays an important role through monitoring and evaluating the steps made in achieving the agreed development targets.

T2.10.2: Data Sources / Data Collection/ Data Quality of Agricultural and Rural Statistics in Myanmar
(Abstract Id: A2-4-001)

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A key responsibility of the Central Statistical Organization (CSO) is to built a coherent National Statistical System in Myanmar that ensure the comprehensive , accurate and high quality socio-economic statistics are produced and regularly collects, compiles, conducts, presents and disseminates economic and social statistics by using administrative data. Agricultural Statistics have been mainly compiled and published by Economic Division of Agriculture, Livestock and Forestry Section in collaboration with Ministry of Agriculture, Livestock and Irrigation, Ministry of Natural Resources and Environmental Conservation. This paper studies data sources, data collection and data quality of agricultural and rural statistics by supporting the efficiency and effectiveness of National Strategy for the Development of Statistics (NSDS) of the clusters working group to improve the Global Strategy of agricultural and rural statistics.

T2.10.3: For improving administrative statistics on agriculture in Mongolia (Abstract Id: A2-4-007)

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Nowadays, administrative data are becoming increasingly important because they are less costly and easier to use. According to the literature, Nordic countries have transformed their statistical systems where all surveys are register based, in other words, they have transitioned away from traditional data collection for area samples and censuses. Agricultural administrative data are collected by relevant ministries and agencies and provincial offices in Mongolia. The weaknesses in the administrative statistics on agriculture are use of non-standardized questionnaires, unclear statistical concepts, less control or supervision of the data collection process and non-utilization of professional data processing software. The paper presents the strategies for improving administrative statistics on agriculture based on the pilot survey results and literature review and in- depth country assessment to improve agricultural statistics. The first section contains the analysis of the current situation of administrative statistics on agricultural subsectors and SWOT analysis will be conducted in order to assess the capacity to produce administrative statistics. The next section identifies the need of administrative data for evidence based policy making and proposes new data sources, such as using big data. Finally, recommendations for improving administrative data on agriculture have been addressed.

T2.10.4: The integration of administrative data for the identification of the ownership of agricultural land (Abstract Id: A2-4-004)

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Ownership structure of the agricultural land is one of the indicators for functional and justified orientation of agricultural policy-making. Agricultural holdings often rent agricultural land due to insufficient own land, which needs to be statistically measured. Despite adequate administrative registers in the country, this is not explicitly captured in a single data source. Therefore, it was formerly estimated using statistical questionnaires. In the scope of the 2020 Agriculture Census, administrative source data modelling process was developed that will substitute survey questions. Two geospatial administrative data sources (Integrated Administration and Control System – IACS and Land Cadastre) were combined based on their spatial relations. Results were exported in tabular format and combined with two tabular administrative registers (Register of Agricultural Holdings and Real Estate Register). Questions that arose due to joint and mixed ownership of agricultural units were addressed by testing different aggregation methods. The results were validated using historical data and the most accurate approach was chosen for future use. Project results provide quality data on agricultural land ownership – owned and rented land – for the whole population of agricultural holdings at the micro level. Data can be analysed separately for each land use and agricultural holding type. The developed process can be modified and applied elsewhere (both agricultural and other fields) to generate statistics.

Session T2.11: Measuring the Role of Women in Agriculture

T2.11.1: Beyond the sex of the holder: Women and men's decision-making in agriculture in Uganda
(Abstract Id: A2-4-010)

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Agricultural surveys typically ask who in the household is the holder, where the holder is the individual who makes the major decisions about the operation of the household farm. There are two major drawbacks with this approach in agricultural surveys from a gender perspective. One is that household farms may not operate as a single business enterprise under the direction of only one individual. Studies that have explored decision- making in household farms within developing countries suggest that households often have various agricultural activities, including multiple income earning activities, which may be overseen by multiple household members jointly or separately. The second is that when administering surveys, it is typically assumed that the household head is the holder. While it may vary by country and culture, when the head is not designated as the holder, frequently a male household member is assumed to make the major decisions about agriculture in the household and is regarded the holder, unless no male adult is present. As a result, the sex distribution of the holder reflects the household structure—whether it is female-headed or not— more than the operational decision-making dimensions in agriculture on the household farm. Using unique data from Uganda, this study explores intra-household decision-making on cropping and livestock activities of household holdings. The study finds that for the majority of households in the sample, both men and women make decisions about agricultural production. There are activities that are jointly managed and there are activities that men and women manage separately. Adding specific questions on who makes the decisions about different agricultural activities within agricultural surveys provides a better understanding of the operation of household farms, than only asking who is the holder. This study also finds that for some activities, husbands and wives perceptions differ on women's role in agricultural decision-making. Men, who were mostly designated as the holders in the survey, underestimated their spouse's management of agriculture activities. For this sample, this underestimation does not make a difference in estimates on a holding-level decision-making indicator that aggregates across all activities; however, if unbiased estimates are needed on specific activities, the findings suggest that it may be important that both men and women in the household are asked about their involvement in agricultural decision making.

T2.11.2: Gender statistics in agricultural activity in Mexico (Abstract Id: A2-4-003)

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The main objective of agricultural statistics and, in particular, of an agricultural census, is to measure the structure of agricultural production. In this sense, it is important to obtain data about the labor carried out in the agricultural and livestock production units; specifically, the participation of female labor in this economic activity. The Food and Agriculture Organization of the United Nations (FAO) in its "World Program of the Agricultural Census 2020", recommends capturing data on "agricultural labor", in accordance with the recommendations made by the International Labor Organization (ILO) adopted in the 19th International Conference on Labor Statistics 2013, where reference is made specifically to the "Integration of gender in labor statistics". Similarly, FAO recommends capturing data on the demographic and social characteristics of household members of the producer, regardless of whether it is the predominant activity in the household or if it is only a secondary source of income, being able to obtain information by gender. In Mexico, through the Agricultural Census and through the National Agricultural Survey, labor data have traditionally been captured by gender of each of the occupation categories. Regarding the sociodemographic characteristics, previously only those corresponding to the producer (or producer) were obtained. Actually, the characteristics of the people (men and women) who live with the producer (a) have been added. In this work, it is revealed how gender variables have evolved in agricultural statistics questionnaires, and information (census and survey) on the characteristics of production units headed by women are presented; of the participation of women in the labor force (family members, wage earners and day laborers); and about the characteristics of the women who live with the producer according to their relationship, age and schooling; among other topics.

T2.11.3: Measuring women's empowerment in agriculture in national-level surveys: Recommendations for the 50x2030 initiative to close the agricultural data gap (Abstract Id: A2-4-018)

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Empowering women and girls is critical for achieving development outcomes. Accurate, reliable, and timely metrics to track progress toward gender equality and women’s empowerment are needed for countries to develop evidence-based and inclusive policies to achieve these outcomes. The commitment to collect data and report on the role of women in agriculture is evident. Indicators capturing the role of women and dimensions of empowerment are part of global development agendas and policy frameworks such as the United Nation’s Sustainable Development Goal 5 and the African Union’s Comprehensive Africa Agriculture Development Program (CAADP). Bangladesh’s Integrated Household Survey, a national- level survey, collects data on empowerment using the Women’s Empowerment in Agriculture

Index (WEAI), and 86 development and/or research organizations in 52 countries collect some form of the WEAI. Despite these gains in measuring and reporting on the role of women in agriculture, few national-level household and/or farm surveys collect comprehensive data on empowerment—and specifically economic empowerment--that are comparable and relevant across countries. Furthermore, empowerment is a multidimensional and complex concept, and existing surveys that measure core dimensions of women's empowerment are time-consuming and expensive to collect. Trade-offs are necessary to develop a comprehensive measure of empowerment, and one that is appropriate and resource-efficient to collect. First, this paper will examine definitions of empowerment and how it is currently measured in national-level and/or population-based surveys. Indicators that capture the extent to which women are reached by agricultural programs and policies, and those that measure whether women benefit economically from them will be identified. Dimensions of empowerment--specifically economic empowerment--that are measured in these surveys will also be examined, as well as core components of empowerment that may be excluded. The second part of this paper will examine the empirical evidence on empowerment and its conceptual underpinnings. Recent research on intra-household cooperation and the role of men in that process will be explored. A discussion on the extent to which an empowerment metric or data can be specific to the agricultural population and apply more broadly to an understanding of structural transformation will follow. Studies that examine the relationship of women's empowerment and outcomes such as food security, nutrition, and economic opportunity will also be reviewed. Finally, recent efforts to develop and improve how the role of women in agriculture and women's empowerment is measured will be explored. To what extent can existing sex-disaggregated metrics be leveraged and/or modified to capture core components of empowerment in national-level surveys? Which components of empowerment should be included and excluded? Sampling considerations will be discussed, and the limitations of an empowerment metric will be considered. What are the benefits to a common, cross-cultural empowerment measure or tool? The development of an empowerment metric would allow countries to report not only on the extent to which women are reached and whether they benefit from agricultural programs and policies, but also whether they are empowered to make strategic life choices and act on them to improve the well-being of themselves, their households and communities.

T2.11.4: The 2017 census of agriculture—Opportunity for education on the role of women on the farm (Abstract Id: A2-4-015)

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Following the 2012 United States (US) Census of Agriculture (Census), the United States Department of Agriculture's National Agricultural Statistics Service (NASS) solicited feedback from various sources that was used to inform the 2017 Census. During that process, several expressed concern that the census questionnaire was not fully capturing the role of women in US agriculture. In response, NASS contracted with the US National Institute of Statistical Sciences to convene an expert panel to review the Census's demographic questions. The panel recommended the move to decision-making questions to identify those most involved in a farm's day-to-day operations. NASS accepted those recommendations and implemented them for the 2017 Census. As a consequence of this and other changes, the number of women identified as being involved in US agriculture increased by 26.6 percent compared to 2012. Further, the decision-making questions have provided new insights into the role of women on US farms. In this presentation, the results of the 2017 Census of Agriculture will be used to explore the variety of ways that women are contributing to US agriculture.

T2.11.5: Women in agriculture in the context of statistics: Armenia experience (Abstract Id: A2-4-005)

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Gender statistics is extremely important for rooting equality of rights for men and women and promoting equal opportunities approach, assessing and reflecting the situation of women and men in the economic, social and political spheres of the country. The statistics allows revealing the differences between the status of women and men, raising public awareness on these issues and regularly exercising equal rights for women and men. It is obvious that there is a common trend for developing countries, where the existing gender inequality undermines balanced and inclusive development of the economy and negatively affects the implementation of poverty reduction measures. Gender shows the relations between women and men that should be "visible" in statistics, which should reflect the place and role of women and men in society, considering them as social and demographic specific groups, as well as various socio-economic realities for women and men in all sectors of the economy, in particular, in agriculture. The agricultural sector plays a key role in the national economy and is characterized by the large number of small-scale holdings.

Share of agriculture in Armenian GDP is about 15-18%, and number of employed is about 31% of the total employed of whom nearly 53% are female. In this context, the role of women in agriculture and its reflection in statistics is crucial, and is an important element of gender relations. However, gender inequality in agriculture is reflected not by less involvement of women, but vice versa. In agriculture, unlike other types of economic activity, the involvement of women`s labor force in many small farms exceeds men, especially in heavy physical work. A significant number of workers involved in labor migration leave their entire burden on women in their small farms. As a result, if statistically it turns out that women's involvement is great in agriculture, in reality women are engaged in low-income and heavy physical work. Taking into account the importance to highlight the vital role of women in agriculture and rural development, the Statistical Committee of the Republic of Armenia (Armstat) included a series of questions in the first Agricultural Census conducted in 2014. The Census results demonstrated women's participation in agriculture labour market, education level, engagement in agricultural activities, and their considerable differences across regions within the country etc. Other solid sources of information are the regularly conducted Households Surveys such as Integrated Living Conditions Survey (ILCS) and Labour Force Survey (LFS). ILCS provides information on changes in the well-being of the population such as poverty, inequality, living conditions, education, health and housing conditions, household consumption, as well as the wide range of multidimensional statistical indicators, one of which are gender differences in the at-risk-of-poverty rate. LFS as another powerful information resource provides information on various aspects of people's work with the distinctions of male-female, urban-rural population by agricultural and non-agricultural sectors, formal and informal employment, working hours, earnings, unemployment, etc. It provides good understanding of what women do and how they behave in the labour market of Armenia. Newly introduced and adapted 19th ICLS Resolution on Statistics of work, employment and labour underutilization in Armenia gives new importance to gender issues. It illustrates the contribution and importance of unpaid work as a female-dominated labour market sector.

Session T2.12: Country Experiences of Data Integration

T2.12.1: Capturing aid flows to food security and food safety interventions in light of SDG 2 (Abstract Id: A11-12-020)

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The success of the Sustainable Development Goals (SDGs) depends on the availability of reliable, timely and granular data to monitor and track down progress made on different goals and targets. For SDG 2, monitoring aid flows to food security and food safety is fundamental for tracking the progress and commitment by donor countries in ending hunger. Until early 2019, dedicated purpose codes on food security and food safety did not exist in the Creditor Reporting System (CRS), which is the international classification in use for reporting aid activities. This gap was first identified in 2016, by the G7 International Symposium on Food Security and Nutrition held in Tokyo, Japan. The G7 organizers advocated for better measurement of development cooperation activities in the fields of food security and nutrition within the CRS system. Based on the work undertaken at FAO, in 2019 the OECD – which is the custodian of CRS classification - has approved three new purpose codes related to food security and food safety interventions. Donors, multilateral organizations and private donors traditionally report aid activities to the CRS, a system managed by the OECD. Using the same classification, the International Aid Transparency Initiative (IATI) has provided a wider platform to disseminate information on development cooperation, accessible to different stakeholders. Both reporting platforms provide a venue for identifying, tracking, and monitoring aid flows aimed at financing food security and food safety interventions, in the framework of SDG2. This paper demonstrates how food security and food safety interventions can be tracked in the CRS and IATI using data scraping techniques on publicly available aid data. It shows how the new codes on food security and food safety apply to FAO activities and projects. For instance, more than 11% of FAO regular programme flows on development assistance corresponding to 53 million USD are addressed to food security and food safety interventions, with Africa as major recipient. Aid expenditures coded against these new codes are analysed and the main donors and recipients are highlighted. The positive effect of the introduction of the new purpose codes in clearly identifying food security/food safety related aid is measured and shown. Options are presented for capturing exhaustive codes and activities related to food security interventions that occur in multiple sectors, which would have been difficult to track without sector-specific codes.

T2.12.2: Technical and institutional challenges in providing access to agricultural survey microdata: The experience of the Uganda bureau of statistics (Abstract Id: A10-11-012)

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The Directorate of Agriculture and Environmental Statistics (DAES) of the Uganda Bureau of Statistics (UBOS) has been implementing an Annual Agricultural Survey (AAS) since 2017. The AAS, designed with the purpose of collecting high quality and disaggregated data to study the performance of the agricultural sector in the country for better Planning, policy making and research. The AAS, provides

detailed information on agricultural households and their production activities that is useful for monitoring the National Priority Indicators of Uganda, the CAADP and SDG Indicators. In 2018, UBOS formally engaged with the Food and Agriculture Organization of the United Nations (FAO) and integrated the AGRISurvey methodology into the AAS. This was implemented in the second agricultural season of 2018. The AGRIS framework recognizes the importance and benefits derived from an effective and secure dissemination of non-confidential agricultural microdata and as such UBOS has devoted a great deal of efforts in creating the institutional and technical environment for providing access to microdata collected through the AAS. This paper presents the legal, ethical and technical challenges faced by UBOS in setting up a microdata dissemination program that called for a collaborative effort of various directorates within the statistical agency. From an institutional perspective, this included the review of UBOS' statistical dissemination policy, which resulted in the drafting of a new organization-wide dissemination policy along with the selection of specific access models for the AAS microdata files and the preparation of the associated terms of use. From the technical point of view, disseminating microdata files implied several steps of implementation following international standards in line with IHSN recommendations. First, the existing NADA catalogue and related IT infrastructure needed to be updated. The catalogue can be potentially used not only for the dissemination of DAES microdata products but also for providing access to any other microdata files, along with the related documentation, produced within UBOS. Secondly, the metadata and the related external resources to document the survey have been prepared in line with DDI-metadata standards. In addition, an accurate process of statistical disclosure control has been put in place in order to protect data confidentiality and respondent's identity. Given the limited literature and experience available on agricultural microdata anonymization and dissemination, results presented through this paper could serve as a point of reference to other National Statistical Institutes wanting to implement a similar process.

T2.12.3: Developing an integrated system of agricultural census and survey programme for monitoring SDGs at national level-Issues and challenges (Abstract Id: A2-2-030)

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Developing an Integrated agriculture census and survey programme is an efficient way of meeting the data needs of the agriculture sector considering the limited resources available to the country statistical systems. In a federal structure where a number of stakeholders are responsible for data collection relating to agriculture sector including ministries of agriculture, NSO and their counterparts at the provincial level, operationalizing an integrated survey programme is a challenge. Each stakeholder collects data keeping in view its own requirements which may or may not be in sync with the other sources of data in the statistical system. In Indian context, definition of farmers adopted in population census differs from the agricultural households adopted by NSSO in Situation Assessment Surveys which in turn is also different from the operational holders defined in the agriculture census programme of the ministry of agriculture or use of differing classification structures makes it difficult to link/compare these data sets. In some cases there are issues of non reconciliation of data coming from different agencies. Data collected through Agricultural censuses already meet requirement of a number of indicators for SDG monitoring. Besides providing structural statistics which do not change rapidly over time, there is a big scope and challenge to leverage the integrated agriculture census and survey programme to fill the data gaps for SDG monitpring. In India, for indicator 2.3.1, productivity per hectare for rice and wheat has been proposed as a proxy indicator for productivity of small scale food producers and for 2.3.3 proxy is gross value added per worker. This is mainly on account of lack of data specific for small scale food producers by class of farming sizea and gender.

Ministry of Agriculture in its report on doubling farmers income has suggested that productivity needs to be defined as a measure of gainful income and not only as a measure of physical productivity. While some data at national level is available under cost of cultivation studies, its sample size may not be adequate to measure these indicators at sub-province level with accuracy. Small-scale food producers needs to be properly defined in the Indian context and sample size increased to enable better estimates for these indicators. In India, a farmer is one who owns land and possesses a revenue record that establishes his right, title and ownership. This record of right offers him a right to access all benefits that the government provides. Currently, this definition tends to exclude the land less cultivator, fisher, nomadic livestock rearer etc. who are unable to access the government support system. Integrated agriculture census and survey programme therefore needs to make appropriate changes in the concepts and definitions to allow such demand from stakeholders. The paper analyses the issues and challenges in the development of an integrated system of agriculture census and survey programme in a federal structure of governance and suggest possible changes to meet various demands of the stakeholders and bring in the required consistencies across data collections and remove duplications where necessary

T2.12.4: Assessing input use dynamics in Indian farms with representative cost of cultivation surveys (Abstract Id: A4-6-052)

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Indian agriculture is undergoing a significant change in input-use away from traditional inputs like human labour, bullock labour, farm-grown seeds, manure and traditional methods of irrigation towards modern inputs like improved seeds, chemical fertilizers, farm machine and large-scale use of tubewells for irrigation. It is pertinent to evaluate the effect of such transitions on crop production cost and profitability of crop enterprise. It is also important to ascertain whether the change in cultivation cost, if any, is due to the changes in level of input-use or its prices. The changing relative price of the factors of production prompts farmers to partially substitute the related factors (e.g., farm labour with machinery) in order to maximize their profits. The evaluation of effect of factor substitution on crop cultivation cost is useful in devising suitable strategies for controlling the cost inflation in the country. These aspects can be examined using Cost of Cultivation Surveys (CCS) data. CCS, which is being regularly conducted by Indian Government since 1970-71, provides valuable plot-level data on various aspects of farm enterprises. Presently, representative CCS are conducted in 19 major crops producing states and the data is used to monitor farm level insights and devise various policy measures taken by the Government. Specifically, this study has examined economics of crop cultivation at the aggregate level over the past 25 years, identified sources of cost escalation and evaluated the effects of factor prices, substitution and technological effects on the production cost. The results reveal that a disproportionate change in gross return vis-à-vis cost resulted in varying rate of return from crop enterprise during the past 25 years. During 2007- 08 to 2014-15, the average cost inflation reached the highest level of 13 per cent, more than half of which was contributed by the rising labour cost alone. Further, at the aggregate level, use of physical inputs increased only marginally and a large share of the increase in the cost of cultivation was attributed to the rising prices of inputs. The estimated negative and inelastic demand of inputs revealed a great scope to reduce the cost by keeping a check on input prices, particularly labour wages. The estimated elasticity of substitution indicated imperfect substitution between labour and machine and the present level of farm mechanization is inappropriate to offset the wage-push cost inflation in Indian agriculture. It is therefore necessary to accelerate appropriate farm mechanization through the development of farm machinery suitable and economical at small farms and improvement in its access

through the custom hiring. The study has also revealed a slow rate of yield improvement to offset the rising cost.

Sub-Theme T3: Data Dissemination & Communication

Session T3.1: Data Dissemination

T3.1.1: Agricultural Data Dissemination and Communication with the Effectiveness of Sustainable Development Goals (SDGS) in Myanmar (Abstract Id: A3-5-003)

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This paper studies the quality of Agricultural statistics by supporting the effectiveness of National Strategy for the Development of Statistics (NSDS) of the clusters working group to advance and promote data production and dissemination. The Central Statistical Organization (CSO) regularly collects, compiles, conducts and presents economic and social statistics. CSO conducted various social and economic situations of the country in terms of statistical indicators. CSO produces Agricultural statistics such as Food Balance Sheet (FBS) and Food Availability /Supply (Person /Day) in Dietary Energy Supply Per Capita Calorie from secondary data and administrative records with the Food and Agriculture Organization (FAO) Guideline. NSDS is very vital to develop National Statistical System which is more inclusive for the statistical activities by participation of Agriculture sectors for requirements data of the Sustainable Development Goals (SDGs). The statistical cooperation mechanism has been established by the Committee on Data Accuracy and Quality of statistics to strengthen not only horizontal but also vertical cooperation with the Agriculture and Rural Statistics Cluster. Therefore, Data Dissemination and Data Communication of Agricultural statistics are necessary to improve in making better policy, planning, implementation, monitoring and evaluation for the 2030 Global Development Agenda.

T3.1.2: Benefits of treating data from government institutions as public asset in Malawi (Abstract Id: A3-5-004)

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Malawi is a small, narrow, landlocked country in sub-Saharan Africa sharing boundaries with Zambia in the west, Mozambique in the east, south and south-west and Tanzania in the north. The country is divided into three administrative regions, namely the Northern, Central and Southern Regions. There are 28 districts: six in the Northern Region, nine in the Central Region and 13 in the Southern Region. Malawi is the poorest country in the world, with a gross domestic product per capita of US$ 290 in 2009. Poverty levels are high: in 2009, the proportion of the population living below the poverty line was estimated at 39%, a slight drop from 40% in 2008. In rural areas, 43% of the population lives below the poverty line, while in urban areas this proportion is 14%. Malawi is predominantly an agricultural country, with this sector accounting for about 35% of the gross domestic product, 93% of export earnings (primarily tobacco), and providing more than 80% of employment. Low literacy levels, especially among women, and the prevailing cultural diversity impact on the lives of Malawians, including their health-seeking behaviour and acceptance of new developments in the fields of agriculture, health and education. Malawi

needs a lot of demand driven research to be done in its key development priority areas to guide the government in a making policy that are more efficient. Usually both public and private research institutions and the academia do not have enough resources to conduct research that country needs to turn around its economy, livelihoods, agricultural sector among others. Unfortunately, the little research that is been done, its results are not accessible to all users. As a result, most to the data generated with the limited resources are under mined as other potential users cannot access it. There is a need to make full use of the data that is being generated by our research and other institutions to command direction of our policies. Most of the data generated by government institutions are supposed to be treated as a public asset and made accessible to all potential users. Unfortunately, some potential users of data are denied the opportunity because of bureaucratic process to approve the release of the data and fear that the public will know the truth. Malawi is celebrating the passing of Access to Information Bill in Malawian Parliament in 2017 which provides that data be made fully available to the general public to speed up our country's growth. The Act was assented on by the president (Prof Arthur Peter Mutharika) on 14th February 2017 and gazetted on 16th February 2017. No researcher or any other data user should be denied access to data more especially the one generated using public resources. This development provides an environment for Malawi's status to turn around due to more efficient policies as well as efficiently using resources for research as unnecessary duplication of research will be minimised.

T3.1.3: Moving to a more user centered design for data dissemination at the US department of agriculture's national agricultural statistics service (Abstract Id: A3-5-034)

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Like many other statistical agencies, the USDA's NASS publishes statistical reports and data both in traditional publications and in a number of on- line electronic formats. Over time, electronic web based data access has become more and more important to data users. However, many of the products available were developed to accommodate the statistical production processes with less consideration of the needs of data users. NASS has recently begun a strategic initiative to redesign the way it provides data to its users. Beginning with the 2017 Census of Agriculture, new data visualizations and methods to access detailed data are being developed using a user centered design process. This included identifying key data user personas and audiences and designing to address their needs.

T3.1.4: USDA's 2017 census of agriculture communications plan: An integrated approach to reaching data providers and users (Abstract Id: A3-15-003a)

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The U.S. Department of Agriculture's National Agricultural Statistics Service (NASS) collects and disseminates a comprehensive census of agriculture every 5 years. In 2017, we asked approximately 3 million farmers and ranchers to provide in-depth information about themselves and their farm businesses. The results of the census, released early in 2019, are highly anticipated among data users for a broad range of important purposes. The diversity of agricultural production and producers as well as the use of data is enormous. With limited staffing and budgets, NASS developed and implemented integrated communications plans for both data collection and dissemination. In this presentation NASS will share the development of these plans as well as what was successful or not in the implementation.

T3.1.5: World Bank and IHSN open source solutions for curation and dissemination of microdata
(Abstract Id: A3-5-006)

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The World Bank Data Group and the International Household Survey Network (IHSN), which it coordinates, are providing data discovery and management tools to producers of microdata in over 80 countries and agencies. These tools cover all phases of survey implementation, from survey design to data dissemination. Our tools include open source DDI (Codebook) compliant data curation tools, comprising: A Metadata Editor, Data Deposit Application and Data Dissemination Application. Our tools are being used in National Statistics Offices, the main data producers in developing countries, as well as increasingly by universities and international development agencies like FAO. Programs supported by the World Bank and the IHSN have resulted in the documentation, using DDI, of thousands of surveys from developing countries. The metadata for these surveys is available in developing country national statistics office catalogs, International Agency catalogs and\or the IHSN catalog. In this paper we introduce a new set of multi-data and multi-standard World Bank tools and schemas that strengthen the ability for agencies to disseminate survey data but also extend functionality to the ability to document and disseminate other types of data which are increasingly being integrated with survey and agriculture survey data. This includes geospatial, and time series data.

Session T3.2: Open Data

T3.2.1: Research data management in Indian agricultural research system and its accessibility
(Abstract Id: A3-5-035)

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Agricultural sector in India supports nearly half of total employment and accounts 16% of Gross Domestic Product. The technological advancements in Agricultural Research made it possible to make India self-sufficient to meet its food requirement. Now, India is not worried about famines or temporary short-fall in food production but worried in terms of handling problem of plenty. With growing population with increasing purchasing power and change in dietary habits throw different challenges to Indian Agricultural Sector. The problem now is to address multiple challenges such as to increase the food production in a sustainable way with judicious use of inputs and minimum damage to environment. Apart from advanced research, Indian Agriculture is looking for other means of achieving this, particularly using Information Technology. It is expected that with increased awareness of modern tools, interests by software professionals along with private investments, Indian farming shall move towards digital. In this context, big data tools and techniques are required to solve complex and unique problems of Indian farming. There are several areas in Indian Agriculture, where we expect data sizes are going to increase very rapidly. Some of them would be due to increased use of sensors to monitor soil, moisture, biotic and abiotic stresses at farm level. Due to small land holding, even if a miniscule fraction of cropped area (say 5-10%) adopts Internet of Things (IoT), the data generated would be manifold as compared to other countries. Mechanization, particularly at harvest stages, are increasing at a rapid rate due to shortage

of labour at different parts of the country. The sensors available in harvesting machine again could provide valuable inputs to farming for the next season to optimize input use so as to maximize yields. Regional/local planning using Geographic Information System (GIS), remote sensing is another area which requires large data processing. Besides, personalized advisories to the farmers are getting increasingly popular, which again expected to produce data that can be analyzed using text analytical tools to improve advisories.At Indian Council of Agricultural Research (ICAR), apex body of agricultural research and education at federal level, the biggest challenge is to manage research data and transforming them into usable knowledge. ICAR has come up with research data management guidelines and it is currently under implementation phase at all its research institutions. KRISHI - Knowledge based Resources Information Systems Hub for Innovations in agriculture, is an initiative to bring its knowledge resources of all stakeholders at one place. The KRISHI portal (https://krishi.icar.gov.in) is being developed as a centralized data repository system of ICAR consisting of technology, data generated through experiments/ surveys/ observational studies, Geo-spatial data, Publications, Learning Resources etc. Besides helping all stakeholders to access latest and relevant information, various personalized services could be build around KRISHI portal. This helps in improving (i) internal research data management using common tables as web services for interoperability, (ii) Data accessibility to researchers as a combination of open and restricted access data and (iii) Enhancing Organization's Visibility through open access publications and technology repositories.

T3.2.2: Towards an open policy of microdata dissemination in Africa: Lessons learned from the use of the NADA portal. The case of Senegal (Abstract Id: A3-5-010)

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The accessibility of survey data is a crucial issue that concerns all National Statistical Offices (NSO). As responsible to collect and disseminate statistical data all users' needs, NSO are increasingly faced with growing demands for individual data or microdata. In addition to these pressing demands generally coming from the research community and international organizations, the NSO are also faced with their obligation to preserve the confidentiality of individual data collected from citizens. Whatever the methods employed and the answers given, this issue requires from NSO to take into account the legal environment of statistical production and dissemination and also the mastery of techniques for reprocessing these data to make them accessible, following appropriate devices. In the African countries context, the accessibility of these microdata is more problematic given to insufficiencies and weaknesses of many NSO at this level. Through technical assistance programs implemented by partners between 2008 and 2014, some tools have been developed to support developing countries in improving the archiving practices of statistical survey and data disseminating on web platforms, such as the National Data Archive Portal (NADA). This Portal, installed in many African countries, can play an important role in facilitating microdata access and use. In 2017, we conducted a study which identified 28 Nada Portals, with 871 surveys and censuses published on catalogues. The analysis of this corpus has provided important insights into the level of microdata accessibility and availability of metadata in African countries. For the specific case of Senegal, the NADA Portal is chosen as the main microdata dissemination tool. In our 2017 study, the Senegalese catalog included 126 surveys, offering different types of access. For the updating of the ANSD dissemination policy, mainly guided by an Open Data approach, new directions are planned to further promote access and use of microdata for analysis and research.

T3.2.3: Open classifications for open statistical data (Abstract Id: A3-5-029)

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While international organizations and national governments alike are paying increasing attention to making statistical data available as Open and Linked Data (e.g., by making data available in open formats, accessible through public APIs, and endowed with open licenses), the modernization of metadata and statistical classifications is lagging behind. Despite their ubiquitous use, and the consolidated tradition of considering them as intrinsically associated to data, their treatment remains largely ad-hoc and "local" – they are often published in formats that are barely open and hardly machine-actionable, by means of ad-hoc structures, and usually with no explicit public license. Two major consequences are that much manual work is involved when reusing existing classifications within information systems, and that the maintenance of classifications (and associated information, including mappings and multilingual terminologies) is often a cumbersome an time consuming process, often implying massive duplication of effort. In this paper, we report on ongoing work carried on at the Food and Agriculture Organization (FAO) of the UN, aimed at improving the way statistical classifications for agriculture are managed, published and accessed by information systems and humans alike. This work is carried on with the support of the Bill and Melinda Gates Foundation, and all project outputs are publicly available. In the approach we propose, statistical classifications are made available in open, standard and machine-readable formats, in order to promote their smooth reuse in third party applications. Given that most large organizations collecting statistical data (or branch in them) are at the same time users of some statistical classifications and custodians of others, a network of organizations adopting this approach will ensure that user access constantly up-to- date information. As a consequence, the duplication of work currently happening to make classifications available in information systems, it is expected to decrease dramatically. FAO is currently experimenting with this approach in-house, and plans on extending it to a network of interested organizations. At the time of writing, a number of statistical classifications (including mapping and multilingual terminologies) have been made available as RDF resources , and tool to support associated functionalities are under development and testing. All project outputs are available through the platform Caliper . The technology stack adopted is based on the linked open data style of data publication. It includes RDF, the de-facto standard for publishing data and metadata on the web, to be used as the "master" format from which different formats can be generated (e.g., CSV or JSON). Classification systems, and their entries, are given global identifiers, i.e., URIs (Uniform Resource Identifiers) to make statements on resources uniquely identified on the web. API and tools for editing, querying or provide human-friendly visualizations can consume the RDF and streamline each step in the data life cycle.

T3.2.4: Open microdata? Adapting open data standards for microdata (Abstract Id: A3-5-013)

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Governments and international institutions all over the world increasingly recognize the power of data for improving lives through better policies, research, and economic stimulus. The global movement which advocates for free, and easy data sharing is known as open data. Open data is commonly defined as data

that can "…be freely used, modified, and shared by anyone for any purpose." Accordingly, various principles, frameworks, and methodologies have been developed to operationalize this definition. Among all of them, standards and approaches for metadata, machine readability, and access policies are considered. The United National Statistical Commission (UNSC) recognizes that open data principles support the implementation of the Fundamental Principles of Official Statistics , and that open data should include the sharing of microdata. Indeed there are many countries which publish microdata files, but there is little consistency between metadata standards, data formats, and access policies. Open frameworks are ill-suited to provide countries consistence guidance for microdata dissemination as they fail to take into consideration particularities of microdata. For example, open data frameworks advocate for open access policies which permit commercial use. However, publishing microdata for commercial use incentivizes malicious use of personal data. Another common criteria is the publication of data in non-proprietary formats. However, most non-proprietary forms such as common separated values, and tab-delimited files render data more difficult to analyze because they cannot distinguish between string and factor variables. Thus, users will have to go through recoding and relabeling all the necessary variables to analyze them in common statistical software. Finally, open data policies tend to advocate for the development of open application programming interfaces (APIs) to query data directly, but this is nearly impossible when publishing micro datasets with heterogeneous structures. It follows that the strict application of open data practices to microdata undermines its use. This paper will provide an overview of the most important open data frameworks, identify their short-comings for microdata and make recommendations on how these frameworks can be modified for microdata. The recommendations will be informed by analyzing a database compiled by the containing the main features of microdata dissemination platforms for 73 countries including metadata standards, data formats, and access policies in order to identify best practices, and those that are most closely align to open data frameworks. The results will be a starting point for integrating microdata into current open data frameworks, and providing NSIs with a consistent set of standards and best practices for microdata sharing.

T3.2.5: Mobilizing capacity development for bridging the digital divide in agriculture (Abstract Id: A10-11-010)

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Currently, nearly 800 million people struggle with debilitating hunger and malnutrition and can be found in every corner of the globe. That's one in every nine people, with the majority being women and children. The solution to Zero Hunger lies within existing, but often unavailable, agriculture and nutrition data. Open Data offers a great potential for innovations from which the agricultural sector can benefit decisively due to a wide range of possibilities for further use. The Global Open Data for Agriculture and Nutrition (GODAN) Initiative supports proactive sharing of open data to make knowledge on agriculture and nutrition available, accessible and usable, in an effort to deal with the urgent challenge of ensuring world food security. A core principle behind GODANs work is that a solution to Zero Hunger already lies within existing, but often unavailable, agricultural and nutritional data. Mostly in developing countries smallholder farmers are not harnessing the power of data and must overcome challenges and risks to ensure that investments benefit them. In this case, two are the main challenges that need to overcome: first, to gain access to relevant data and services provided by others and, second, to make sure that any data they share does not actually weaken their positions (Zampati, 2018). Improving data access in agriculture is not only a technical issue; it is also a social and ethical one, having in mind that the world of agriculture is quite diverse, composed of very different types of agricultural methods and farming realities. Today, our society is globally connected and so is our food system, we source our products from all over the world and agriculture is making significant impacts in local communities. A large share of the worlds farmers could benefit from bridging the digital divide (Jellema et al 2015, Berdou and Miguel

Ayala, 2018). To be able to bridge this digital divide we need to strengthen the capacity to access and reuse data. It is important that the digital solutions developed are designed to allow all farming communities to maximize their potential; this is especially true in countries with very low literacy levels and limited knowledge of digital technologies, yet where the untapped agriculture potential remains among the highest in the world. In this presentation, we will share our experiences from the GODAN Capacity development Working Group and specifically on how we can bridge the digital divide in agriculture by bringing together various stakeholders globally.

Session T3.3: The Geo-referencing of Agricultural Statistical Results and Sampling Frames

T3.3.1: Geocoding households and farms using what3words (Abstract Id: A3-5-021)

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Household addressing is one of the oldest forms of identifying the location of a building or structure. However over time this form of location based information has never been updated especially in the Pacific. In the rural areas of Fiji for instance most villages do not have a physical address and household locations are merely based on the relation to an object or landmark they are close to. This problem has never seen a sustainable solution until now with the introduction of the what3words addressing system. When attempting to conduct a census or survey it is important to consider the locations that will be visited and to enable the proper capturing of these locations in order to remain accountable to stakeholders and clients that will use the information captured. Fiji has attempted to use the Global Navigational Satellite Systems (GNSS) to capture locations however this was not accurate enough as household locations were at times 20-50m off even at times in another time zone. This is due to Fiji's internet connectivity and I.T infrastructure. And even though there is an existing addressing system, since it is not maintained and updated regularly you can have a number of households that have simply created their own addresses and no one is able to keep this in check due to the magnitude of the correction exercise as well as no government department taking responsibility. What3words provides an opportunity to address every household as well as provide government stakeholders with the much needed information about their people and resources. This is done through how what3words works, through the what3word application the world has been divided into a 3m x 3m square grid. Each grid is given a unique 3 word address and this addressing system works over land and seas. It is through this application that many countries use as a way of addressing their postal services issues whereby you have each household given a random 3 word address thus identifying the household. With Fiji's rural areas there are a lot of farmers who are invisible to the addressing system in place and if they were to be identified via some form of innovative location based system it would make a world of difference in statistics and properly capturing geographic information for an agriculture census.

T3.3.2: The georeferencing of agricultural statistical results (Abstract Id: A3-5-007)

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The National Institute of Statistics and Geography (INEGI) of Mexico, in 2016 carried out the Agricultural Census Framework Updating (AMCA 2016), with the aim of knowing who, where and what is produced, thus contributing with useful statistics for the public, private, academic and social sectors. This was a unique project that was conceived as a precedent to carry out the Agricultural Census in 2017, which was not carried out due to budgetary restrictions. In this event, with the support of digital cartography and satellite images, the surface of each of the country's rural areas was verified and validated, thus forming a national mosaic that constitutes a framework for carrying out surveys of the agricultural sector. The characteristics of each land plot were identified, such as location, tenure, rights, main activity and availability of water; and in those with agricultural and forestry activity, their main crop, livestock and forest species was captured. With the aim of disseminating the results of this updating, INEGI developed an interactive geographic consultation module called Agricultural Census Framework 2016, that relates the statistical information of the land plots obtained with the geographic information of the Mexican territory, from the national level to the area of control (each of the parts in which the Basic Geostatistical Areas –AGEB- are subdivided, in order to have a greater level of detail that allows locating the land plot).The purpose is to provide visual information on maps with a higher level of geographical disaggregation, preserving the principle of confidentiality of information.

T3.3.3: Improving paddy statistics in Indonesia: Implementation of a crop cutting survey using area sampling frame (Abstract Id: A2-2-013)

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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.

Session T3.4: Dissemination of Agriculture Survey and Census Microdata

T3.4.1: Agriculture microdata dissemination and archiving system in Nepal (Abstract Id: A3-5-014)

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The Central Bureau of Statistics (CBS) of Nepal has a long history of taking agriculture census and surveys in Nepal. It has been producing a basic structural data on agriculture through agriculture censuses since 1962 in every ten years. The last agriculture census taken in 2012 was 6th census in the series. On the other hand, a numerous annual and ad-hoc agriculture surveys are also taking place between two censuses. Like production, the CBS has been also adopting different methods for disseminating agriculture statistics such as publications, CD-Roms and web dissemination. Although most of the data published are in aggregated form, the CBS has been also publishing its microdata of recent agriculture surveys and censuses for further analysis and research use. The second priority of Busan Action Plan for Statistics (BAPS) emphasizes in promoting open access to and use of data, especially open access to microdata of surveys and censuses. The microdata of survey and census is considered a valuable resources for in-depth research and data integration. A timely, reliable, comparable, relevant, and accessible agriculture data is very important for better design, monitoring and evaluation of agricultural plans and policies for a country like Nepal with agriculture based economy. In line with the recommendations of BAPS and the main thrust of the open data initiative, the CBS has adopted a web-based survey cataloguing system NADA (National Data Archive) in 2011 for archiving and disseminating microdata of new agriculture surveys and censuses conducted by the CBS. The NADA serves as a portal for researchers to browse, search, compare, access, and download relevant census or survey information including microdata in compliance with the data dissemination policy of the data producing agency. The agriculture censuses from 1982 and a numerous surveys are available in the CBS NADA for user access. This paper adopts a qualitative approach to review and present the current practices of agriculture data and microdata dissemination and archiving system in CBS Nepal. It presents the architecture of NADA functionality; takes stock of agriculture surveys and censuses published online in NADA; discuss on the dissemination policy that facilitates easy access to microdata; and provides a list of possible food and agriculture related socio-economic SDG indicators that could be drawn from the NADA repository. It also compare the usual practice of onsite collection of microdata by users with the web dissemination method through NADA and tries to show the importance of web-based dissemination platform of micrdoata for easy access.

T3.4.2: Disseminating European data at farm level while keeping confidentiality: Scientific use files and homogeneous spatial units (Abstract Id: A3-5-011)

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Eurostat has received Farm Structure Survey microdata since 1990. These data are collected by Member States through both the decennial agricultural census and intervening sample surveys. More than 13 million farms in the EU were covered by the 2010 agricultural census. Data were collected for between 250 and 400 variables for each farm including, for the first time, geographic coordinates for all agricultural holdings. The European Statistical Law provides for common principles and guidelines that ensure the confidentiality of data used for the production of European statistics and the transmission and access to confidential data. This law also states that access to confidential microdata by researchers for scientific purposes should be improved, without compromising the high level of protection that confidential statistical data require. One way in which eligible researchers can be provided with access to confidential microdata is through Scientific Use Files. Data are partly anonymised and, after agreement with the National Statistical Institutes, can be used by researchers in previously accorded research entities. In these files, the risk of identification of the statistical units is reduced to the appropriate level. This is achieved by recoding the identifying variables, removing the detailed geographic information and some variables about the farms and their management, the aggregation of more detailed variables on crops and animals, and the top-coding of the holdings with higher values of numerical variables. Whilst partial anonymisation reduces the disclosure risk, a researcher must still verify that the research results are no longer confidential and destroy both the scientific use files and any confidential data that have been derived, at the end of the period specified in the research proposal. The microdata are partly protected by the deletion of the detailed geographic information. Nevertheless, there is significant demand for geographic data for modelling purposes. Confidentiality of geographical data poses specific challenges. To address this, regular grids of 10x10 km, 20x20 km and 60x60 km are produced for selected crop areas and livestock numbers. The process includes the rounding of values and assigning missing values to those grid cells with confidentiality issues, according to a set of rules. A gap filling method has been developed and is applied in a subsequent step. The data are then distributed to Spatial Units based on the 1x1 km INSPIRE grid, guaranteeing that the risk of identification of the statistical units is also reduced to the appropriate level. This paper describes the methodology used to produce scientific use files and homogeneous spatial units from European farm structure microdata.

T3.4.3: Improving data dissemination and use in the Pacific region (Abstract Id: A3-5-015)

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Access to well documented and comparable development microdata is critical for forming and evaluating food security and natural resource policy, and for reporting against indicator frameworks, such as those embedded in the Sustainable Development Goals. With financial assistance from the World Bank through

the Trust Fund for Statistical Capacity Building, we have implemented a project to improve data dissemination and use in the Pacific region. The project has: i. Established the Pacific Microdata Library; ii. Standardised census and survey microdata; and iii. Developed appropriate approaches towards sampling in small island states. National statistical agencies, line ministries, and other organizations in the Pacific region produce valuable datasets through their censuses, surveys, and administrative data collection activities. These data, however, remain largely under-exploited. Many data producers in the Pacific region do not have the resources, technical capacity, or mandate to conduct in-depth analysis of the data, and researchers outside these organisations do not have easy access to the microdata. In addition to not being sufficiently disseminated, many datasets are not properly documented and preserved. We have addressed these issues through the establishment of the Pacific Microdata Library (http://pdl.spc.int/), which is responsible for acquiring and documenting data to ensure their long term preservation and to maximise their dissemination and use. Establishing national data archives is not a realistic objective in much of the Pacific region. As such, the Pacific Microdata Library is being centralised and administered by SPC, which is the principal scientific and technical organisation in the Pacific region providing development assistance to its 22 developing member states in sectors such as agriculture, fisheries, health and education and in areas such as statistics, climate change and social development. The Pacific Microdata Library: a) preserves microdata to prevent data loss; b) documents datasets in accordance to international standards to improve their useability; c) publishes metadata to increase data discoverability; and has developed data governance frameworks to facilitate microdata dissemination and use. The Pacific region has made significant progress in ex ante statistical data collection standardisation. Regionally standardized instruments, classifications and methodologies have been developed to ensure that Pacific statistical collections meet international standards and allow for the production of consistent and comparable data across the Pacific region. In consideration of the significant progress made in harmonizing ex ante statistical collections, to facilitate rapid and comparable data use, we have implemented ex post statistical collection microdata standardisation. We have also developed guidelines for sampling in the context of the small island states of the Pacific. The paper primarily focuses on the establishment of the Pacific Microdata Library and the protocols and governing instruments that were developed to facilitate the process from data acquisition through to data dissemination. The paper will briefly expose the reader to the harmonisation and sampling procedures that were developed under the project.

T3.4.4: Microdata dissemination in AGRISurvey project: challenges, solutions and country experiences
(Abstract Id: A3-5-008)

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The Agricultural Integrated Survey (AGRIS) developed by the Food and Agricultural Organisation of the United Nations (FAO) is a farm-based modular 10-year survey model designed as a cost-effective tool to improve the production of quality data on the technical, economic, environmental and social dimensions of agriculture. In 2016 the FAO Statistics Division began supporting countries to implement the AGRIS model at national level through the AGRISurvey program. Besides enhancing data collection, one of the core objectives of the AGRISurvey program is to support partner countries in the dissemination of the collected agricultural microdata, which are organized in the Open Agricultural Statistics (OAS) component of AGRISurvey The objective of the OAS component is to overcome existing barriers that are hampering the accessibility and usability of agriculture data by users, including by government agencies. Particularly, the OAS works with partner countries at increasing access to agricultural statistics by

promoting data dissemination policies and programs as part of institutional processes and by improving dissemination practices for greater accessibility and usability of the data, including micro-data. The practice of and, hence, the experience with dissemination of microdata from agricultural surveys is limited. Reasons are the specific characteristics of agricultural survey data, such as the inclusion of (large) commercial farms and multi-level nested modules (household, parcels, crops). Also, in some countries, the agricultural survey is conducted by the Ministry of Agriculture, which may have less experience disseminating data than the National Statistical Office. FAO helps countries where AGRISurvey is implemented in fulfilling all prerequisites for successful microdata dissemination, which are of legal, ethical and technical nature.

This includes the preparation or amendment of the statistical law, dissemination policy and microdata access policy, setting up an appropriate catalogue and the necessary infrastructure for implementing the microdata dissemination protocol, documentation (DDI-compliant metadata) as well as microdata anonymization. This paper presents the particular challenges with respect to disseminating microdata in the AGRISurvey project as well as the solutions developed to overcome these. Guidelines are developed to documenting, anonymizing and disseminating agricultural survey microdata as public use file or scientific use file. This paper describes all the components of the micro dissemination process and highlights issues particular to agricultural surveys and AGRISurvey. The focus is on the practical anonymization, as the microdata dissemination process of agricultural survey data differs mostly in this respect from the same process for other survey data. The paper illustrates these by using the practice in Senegal and Uganda, which are among the first countries implementing the OAS component of AGRISurvey. The guidelines and shared experience can be beneficial to other countries implementing AGRISurvey or planning to disseminate agricultural survey microdata.

T3.4.5: Anomymisation of enterprise microdata stemming from agricultural surveys (Abstract Id: A3-5-009)

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Originally created to provide information to governmental stakeholders, National Statistical Institutes generally release a wide range of products and services. The dissemination of information should always be performed in full compliance with the regulations pertaining to the privacy of respondents. While the delivery of tabular and aggregated data continues to satisfy some user needs, the demand for more flexible survey outputs for a broader variety of users steadily increases. The easiest way to allow for flexible outputs is the microdata release so that users can carry out their own analyses. To avoid confidentiality breaches, a two-stage statistical disclosure control procedure may be applied. In a first stage, given a disclosure scenario, the risk of disclosure of each unit is estimated. Then, a masking method is applied in order to guarantee that no confidential information could be retrieved from the disseminated microdata file. This paper illustrates the application of this two-stage statistical disclosure framework to business microdata. Data from the Italian Farm Structure Survey is used to catch several striking aspects of agricultural surveys on holdings. After the removal of direct identifiers, e.g. name, other indirect identifiers (called key variables), such as geographical location or farming type, could still allow the disclosure of some confidential information. Besides general characteristics described elsewhere in the literature, the disclosure scenarios for business microdata should consider several particular issues, mainly related to the known accessibility of public registers and the existence of large enterprises or holdings. These features make business microdata to be considered especially at risk of confidentiality breaches. In business microdata files, both categorical and continuous key variables are commonly registered. Because of the latter, each record is almost a unique case; risk measures based on rareness concepts are not suitable. Whereas skewness is typical for economic variables like turnover or employees,

sparsity is an additional feature particularly characterizing agricultural surveys. Indeed, since any agricultural phenomenon is highly related to the territorial characteristics, the detailed geographical location of the farms becomes analytically valuable. At the same time, using in depth geographical classifications, record-level measures on phenomena like area and production of crops, use of fertilizers or structure of livestock herds unavoidably become more sparse. Together with particular constraints related to the data structure, e.g. linear or hierarchical relationships between units or variables, the above discussed uniqueness, skewness, sparsity and in depth geographical level should be considered in both disclosure risk assessment and disclosure limitation stages. Focusing on agriculture-related variables, the paper will first compare the main disclosure risk approaches used when disseminating business microdata, i.e. record-linkage and outlier identification procedures. Then, the paper will discuss how different perturbation methods, e.g. model-based, microaggregation or adding noise may be adapted to agricultural surveys. Moreover, two geo-masking methods, i.e. local restricted imputation and tessellation-based geographical aggregation will be illustrated.

Sub-Them T4: Use of Statistics for Policy Making & Research

Session T4.1: Farm Income and Farm Economy

T4.1.1: Impact of crop diversification towards high-value crops on farm income and poverty in India (Abstract Id: A4-6-034)

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In India, at the policy level, there is a substantial shift of focus from enhancing food production to promoting farmers' income and welfare. Given the resource constraints and challenges associated with Indian agriculture, it is pertinent to device feasible strategies to improve the economic welfare of farmers. Diversification towards high-value crops can be a potential source of income enhancement and poverty reduction. The link between cultivation and area share of high-value crops on net farm income and poverty status of rural agricultural households in India is not very well documented. Using, large national farm household level data and advanced estimation techniques, we investigate the impact of cultivation of high- value crops on farm households' economic welfare in India. The study relied on two repetitive rounds of national representative survey of rural agricultural households (NSS 59th and 70th rounds) comprising a sample of 74,724 farm households. We use Propensity Score Matching and Dose Response Function analysis to estimate the effect of cultivation and area share of high-value crops respectively. Findings show that, in India, cultivation of high-value crops does indeed play a major role in enhancing net farm income of rural farm families. Farm households growing high- value crops had higher net farm income of about Rs. 20650/ha and Rs. 27270/ha than nongrowers in 2003 and 2013 respectively. Results of propensity score matching indicate an average treatment effect of Rs. 5800 for high-value crop cultivators. Moreover, using continuous treatment matching, we found positive significant between the area share of cultivation of high-value crops and net farm income. Rural farm households need to allocate at least 40 percent area to high-value crops to significantly enhance net farm income. Our results also show that growing high-value crops has a significant impact on poverty reduction among farm families. The probability of poverty reduction was higher for the treatment level in the range of 40 to 60 suggesting that the farmers need to allocate at least 40 to 60 percent of the cultivated area to high-value crops to escape poverty. Hence, concentrated efforts need to be taken to promote high-value crops cultivation in India.

T4.1.2: Looking beyond the farm and household: Determinants of on-farm diversification in India (Abstract Id: A4-6-011)

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Apart from farm and household factors, there is a larger context and non-farm environment under which a farm operates. This study contributes to the understanding of such pull factors which are external to farm and household conditions which impinges on on-farm diversification process. Although a lot of studies have looked into the contribution of farm and household factors, literature is often oblivious to the contribution of external factors towards farm diversification. This paper tries to fill that gap in the literature by bringing in that extra information beyond the control of the farm and household which can significantly affect farm diversification. Using latest data on agricultural households in India, and coalescing it with external pull factor information drawn from several other sources, this paper assesses the contribution of farm, household, village, district, and state variables towards on-farm diversification decision. Applying a novel residual inclusion method of controlling for endogeneity, a three stage residual inclusion model is estimated. Based on the estimation results, this study finds that village network influences on-farm diversification through cultivation of same crops as by the neighborhood. This reaffirms that farm household reap benefits from 'economies of density'. Results also show that there is a broader agro-ecological environment under which a farm operates and these external factors could significantly influence on-farm diversification decision. Provision of accessible public infrastructure such as schools, colleges and public transport positively impacts on-farm diversification. For urbanization and structural transformation to have a positive influence on farm diversification, viable labor replacing technologies should be made available to the agricultural sector. Capital and total expenditure on agricultural and allied activities raises the probability of diversification during the lean period of rabi season.

T4.1.3: Modelling Farmer Choice Between Crops and Raw Milk Production in Senegal (Abstract Id: A4-6-004)

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In Senegal, livestock is the second most important activity in the agricultural sector after agriculture. It constitutes 4% of Gross Domestic Product (GDP). Domestic production of dairy products remains low and leaves a structural deficit to be filled by strong imports. The level of production of raw milk is very low compared to the country's assets such as important animal and pastoral resources. A principal component analysis allowed us to identify three homogeneous types of dairy farming in terms of their structures in terms of area allocated to crops, herd size, means and production strategies. The modeling of the choice of the activity practiced (crops or raw milk production) by representative households of the different types of dairy farming made it possible to make three observations. First, dairy farming remains even more profitable than agricultural activities in the southern regions, despite the high yields of cultivated crops. Then, in urban areas, there is an inkling of the farmers in the production of cow's milk because of a rather strong demand and a very interesting price level. Finally, the rural areas of Kaffrine and Louga (Type 3) which focus more than three quarters of productive resources are identified as carriers of milk production in Senegal. These are the areas whose production can reach an industrial threshold. The introduction of a (half) feed subsidy will result in a doubling of production in Type 3 dairy areas and a 60% increase in domestic raw milk production.

T4.1.4: The Well-Being of Pluriactive Farmers in Northern France (Abstract Id: A4-6-005)

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Pluriactivity in agriculture is an old phenomenon which consists of a combination of agricultural (on farm) and non-agricultural (off farm) activities performed by the farmer. That strategy was for a long time associated with “fragility” and “insufficiency” of the farm and we long believed that pluriactivity was a survival strategy or even a way to quit agriculture. However, pluriactivity is a much more complex phenomena motivated by lots of different factors such as income, social openess and it is used by lots of diverse profiles such as teachers, administrative agents... etc. Indeed, pluriactivity no longer concerns only small farms but also professional farms where activities are varied. But this "modern" agricultural pluriactivity very often imposes increasingly strict organizational constraints that require a very high level of management rigor. Moreover, in a number of situations, it is becoming increasingly difficult to tackle two (or more) activities simultaneously. Today, this great evolution of pluriactivity prompts us to ask the following question: is pluriactivity really an alternative agricultural strategy to the classical production model ? For it to be, we believe that pluriactivity must be a strategy that is fully satisfactory for the pluriactive farmer so that it can be sustainable. The aim of this work is to analyze empirically the well-being of the pluriactive farmers of the northern France. In order to achieve this objective, a sample of 67 pluriactive farmers was used. The survey was based on recorded semi-directive interviews, with mixed approach: quantitative/qualitative analysis, allowed a more thorough analysis because it gives full voice to the farmers. Indeed, these interviews allow us to discuss the life trajectory of the farmer, his feelings about the advantages and disadvantages of this practice, as well as his feelings on his satisfaction level and finally his intentions to remain pluriactive in the future. The results enable to define some factors which influence pluriactivity satisfation. The financial situation of the farm, history of the pluriactivity (motivations, context…), the operating mode of the farm and distance between the farm and the other job seem to have a great influence on the level of satisfaction of the interviewed farmers. Moreover, this study confirmed the existence of a “successful” pluriactivity providing a high level of well-being, which allows it to be sustainable. This category is mainly composed of farmers with a second job providing a comfortable income and who work on the farm only as a manager. On the other hand, when pluriactivity isn’t really desired, farmers are quite unhappy and seem to be willing to stop their agricultural activity if nothing change! Indeed, this “unhappy and/or suffering" farmers category cannot find an equilibrium in their dual professional lives and then present the greatest risk of stopping agriculture.

T4.1.5: Impact of climate-smart technologies adoption on yield and economic return of farming household in Benin: A case study of Drought tolerant maize (DTM) varieties (Abstract Id: A4-6-003)

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In the context of climate change, some climate-smart innovation like Drought Tolerant Maize (DTM) varieties packages were disseminated on all the heard of Benin's territory, to increase productivity, yield, income, food security, nutritional status, and poverty. This paper examines with a case study of Drought tolerant maize (DTM) varieties, the impact of climate-smart innovations adoption on yield and economic return, using country-wide cross-sectional data of about 518 maize farming households from 48 villages in Benin. We used respectively net margin, return on labour, return on capital, cost-benefit ration return on investment as farm economic return outcome indicators and maize quantity harvested as a yield outcome indicator. We used the endogenous switching regression (ESR) model framework and to identify causal effects of Drought tolerant maize varieties adoption on yield and farm economic return; two instrumentals variables were used. Significant differences in socio-economic, demographic and institutional characteristics between adopters and non-adopters of Drought tolerant maize varieties were found. So as 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 net margin about 1.78%, return on labour about 7.01%, return on Capital about 128.72%, cost-benefit ratio about 73.57% and Return on investment about 53.35%. On the other hand, we found that there was no significant impact of Drought tolerant maize varieties adoption on yield. This study suggested that earning profit from the farm can help severely food insecure households to achieve acceptable food security status by enabling them to acquire cereals and tubers, pulses, vegetables, and fruits on a daily basis. Our findings point out that Drought tolerant maize varieties can play an essential role in farm economic performances in Benin and indirectly in food security.

Session T4.2: Credit and Investments in Agriculture

T4.2.1: Data-driven Policy for financing agriculture: In the realms of practitioners' endeavours since 1950s (Abstract Id: A4-6-048)

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Success stories in agriculture are associated with positive role of agricultural financing. Spatial and temporal information on agricultural credit by banks and non-banks helps in studying financial penetration, identifying deficient areas that require focussed approach and monitor the effectiveness of policy measures. The paper reviews the efforts put in India for collection of statistics on debt, investment and credit since 1951, which supported major policies for moving away from informal to formal sources of financing and for enhancing productivity in the farm sector. Nation-wide surveys of households supplemented by higher frequency statistics from formal entities provided core inputs for policy-making at national and regional levels and also helped in formulating business strategies by banks and other financial intermediaries. The empirical analysis suggests that the Indian banking sector has been able to provide efficient financial solution and the move away from informal financing has reduced the costs and indebtedness of farmers. The spread of new formal channels are increasing financial access in rural areas. Investment in agriculture has supported food security and mitigated the overall levels of rural poverty. There has also been improvement in risk management systems and processes and the risk perception in the sector is lowered with greater expanse of farm insurance. At the broader level, further policy push is required towards development of institutions and involvement of stakeholders. Moving the agricultural productivity in developing countries to optimal level would require substantially higher agriculture finance. At the micro-level, more attention to financing of value chain would aid in development of the various links in providing inputs, production, processing, storage and trading activities to reduce the volatility in availability and prices of farm products.

T4.2.2: Adequacy of data on credit to agriculture (c2a) in support of the sustainable development goal (SDG) 2 (Abstract Id: A4-6-018)

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The paper examines the possible use of statistics published by central banks on commercial banks' credit to agriculture for monitoring domestic private investment to agriculture, and proposes an indicator for the monitoring of SDG goal 2. Target 2.a of SDG 2 focuses on the necessity of increasing investment in agriculture in order to achieve the SDG 2. Despite the fact that farmers are the main investors in agriculture, there is still no SDG Indicator for monitoring the private domestic investment component of the Target 2.a. In this paper, we propose the Agriculture Orientation Index (AOI) for credit as a potential indicator for monitoring the private domestic component of Target 2.a. The AOI for credit has a great potential for monitoring domestic private investment into agriculture as it normalizes the share of credit to agriculture by taking into account the economic contribution of the sector. The results show that developed countries tend to have a higher AOI than developing countries. This may be due to the fact that agriculture is dominated by large producers; more commercial production; existence of agribusinesses;

higher degrees of mechanization and greater capacity to provide collateral compare to a larger prevalence of small agricultural producers with little or no capacity to provide collateral to access loans from formal financial sector in developing countries.

T4.2.3: Empirical relationship between credit flow and agriculture production (Abstract Id: A4-6-032)

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This paper has tried to analyze the credit and investment pattern and its impact on the productivity of agriculture. The share of the agriculture in the country's GDP is highest till now. It is about 27% of the total GDP in the FY 2018/19. However, the share is in decreasing trend. Broadly, there are two sources of agricultural credit i.e. organized and unorganized. The organized sector includes the banking channel. It includes the commercial banks, development banks, finance companies and cooperatives. The major areas of credit flow in agriculture are credit flow on Farming and farming services, credit flow on tea plantation, credit flow on animal farming services, credit flow on forest/fishing farming and credit flow on other agriculture and agricultural services. The sectoral loan dispersed in the various areas of agriculture from the banking channel has been taken for the analysis. The central bank has the provision of deprived sector lending rate. It frequently revises the rate. Due to this, the trend of the loan disbursement in the agriculture sector has been increasing. The credit flow from the unorganized sector is not taken into account for the study. Those amounts are generally under reported to the authority. Landlords, friends and relatives are mainly responsible for the such type of credit. They generally charge high rate of interest for the service. Those funds are generally taken by those farmers who have not access to take loan from the organized source. There are procedural complexities regarding to the credit taking by farmers. So they prefer to take loan from the unorganized sector. The agriculture sector has not obtained the desired pace of production. The Government of Nepal through the implementation of plans and policies in the yearly budget as well as periodic plans is strengthening the capacity of farmers. It has been subsidizing fertilizers, pesticides as well as credit. They are also in the access to upper level people. Real farmers are deprived of those privilege and facilities. Due to this, farmer limit the production only for subsistence purpose. On the other hand, commercialization and diversification is also impossible for the farmers due to the lack of fund. This directly create adverse effect on the agriculture production. Ordinary least square regression model has been used to analyze the relationship between the credit flow and agricultural production. Similarly, the trends of the credit flow along the various agriculture sectors has been observed graphically to facilitate the paper. The secondary data from the Nepal Rastra Bank (Central bank) and agriculture production from Central bureau of statistics has been used in order to draw the inference. In order to assure the investment and productivity of agriculture, the governments and the development partners should be active in terms of the supervisory and monitoring role. Real farmers should be identified in terms of providing privilege and facilities. Similarly, the targets advocated by the SDGs can have sound figures if the above suggestions and advices are considered.

T4.2.4: The priority setting of proveniences for investment in Iran's agronomy subsector with taxonomy technique (Abstract Id: A4-6-053)

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Since the investment components of national production is therefore locate investments, should follow any particular methodology that the amount of capital and profits back to the point of maximum desire. In this article provinces of the indicators defined terms having the priority investment in agricultural activities and field ranked analysis of different areas of investment for national and regional programs running capital projects is provided. To do this technique factor analysis and numerical taxonomy analysis and cross section data from general agricultural census results in and population and housing 1385 used. Fars province results showed that under most 1382 agricultural and kohgiluyeh va boyer ahmad province minimum capital formation has the ability.Reports by the ministry of commerce of buying wheat farmers in different provinces in recent years also confirm this result.

T4.2.5: Effective funding to agricultural growth in Burkina Faso (Abstract Id: A4-6-035)

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Empirical studies on the relationship between public spending and agricultural growth has always been debated. Most studies found out that investment in agriculture is an effective instrument of agricultural policy to decrease hunger and poverty in developing countries. Burkina Faso appears to be one of the best performing country since the 2003 Maputo declaration to allocate at least 10% of public expenditures to agriculture. However, rural poverty and hunger are still major concerns as farmers still face many challenges including the lack of financial resources to buy inputs for improving their productivity. Agriculture is the key economic sector in Burkina Faso. It accounts for more than 30% of the country's GDP and employs more than 80% of the labor force. This study attempts to give a more holistic approach about investment in agriculture to policy makers in Burkina Faso, by taking into account different sources of investment into the agriculture sector: public expenditure, private investment, development flows to agriculture and foreign direct investment. Based on data collected from the Food and Agriculture Organization of the United Nations (FAO), the International Food Policy research Institute (IFPRI), the International Monetary Fund (IMF) and the National Institute of Statistics and Demography (NISD), the study elaborated an agriculture investment profile which gives a clear understanding of the amount contributed by all sources of investment into the agriculture sector in Burkina Faso. Furthermore, based on econometrics analysis, the paper assessed the impact of the different sources of investment on agriculture productivity and makes policy recommendations on specific sector along the agriculture value chain where investment should be made for greater productivity in agriculture.

Session T4.3: Use of Data for Policy Making

T4.3.1: Estimating the demand function for rice in the Philippines (Abstract Id: A4-6-030)

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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.

T4.3.2: Evidence-based policy making in agricultural development - from data to decision-making
(Abstract Id: A4-6-029)

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Prosperous agriculture and agribusiness are key factors for the economic growth of Georgia. Successful elaboration and implementation of the Rural Development Strategy 2017-2020 and the Strategy of Agricultural Development in Georgia 2015-2020 will serve as a valuable input to the efforts of the Government of Georgia to enhance competitiveness of agriculture and agribusiness in Georgia and contribute to the broad goals of achievement of sustainable growth, alleviation of poverty and overall improvement of economic conditions of the population. Implementation of those strategies requires thorough preparatory analysis of the relevant issues, advanced planning through careful examination of policy options and their efficient execution. None of the above is possible without the proper institutional setup and advancement of analytical capacity, which is dependent on the availability of high-quality statistical information. Challenges and opportunities in agriculture development are becoming more complex, which raises new demand for advanced analytical capacity for a better policy decision. This kind of decisions should be derived from sound economic analysis and established appropriate models. The need for accurate and timely agricultural statistics for highly globalized economic activities is increasing significantly during the last years. Producing comparable and relevant agricultural statistics gains more popularity and is becoming crucial for sector development. Accurate, timely and reliable information provides better capabilities to the decision makers for policy planning. Therefore, there is a high level of cooperation, with the active assistance of donor organizations, between the National Statistics Office of Georgia (Geostat), producer of the official statistics of the agricultural sector in the country and MEPA (Ministry of Environmental Protection and Agriculture of Georgia). To increase the scope and the quality of the statistical data and meet the demand of policymakers in the agricultural sector "The Strategic Plan for Agricultural and Rural Statistics" (SPARS) 2016-2020 has been adopted in 2015. One strategic objective of the SPARS is meeting data needs and improving data processes. Under this objective, among other actions, Geostat should conduct a pilot Farmers' Gross Margin Survey and the survey on greenhouses. Under the same objective, data from the agricultural survey will be used to improve annual estimates of carbon emissions from the agricultural sector and produce main agro-environmental indicators. The proposed AGRIS survey program will cover these needs by improving the existing toolkit and developing additional survey modules. In addition, FAO has selected Georgia as a pilot country for the implementation of AGRIS (The Agricultural Integrated Survey) project. Georgia is the first country in the region where AGRIS Survey is conducted. The project started in July 2018. The project will provide technical assistance to GEOSTAT, but MEPA will also receive new statistical data, which was not available until now. At this stage, it is agreed to add an economic module to the existing survey, which will give the opportunity to get data on the incomes and expenditures of agricultural holdings. Also, it will be possible to calculate the important SDG indicators, which implementation is the responsibility of the Ministry.

T4.3.3: Measuring rural development policy with the help of farm register (Abstract Id: A4-6-019)

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The European Union's rural development policy helps the rural areas of the EU to meet the wide range of economic, environmental and social challenges of the 21st century. Supporting Rural Development is the second pillar of the Common Agricultural Policy (CAP) and within this framework in total around 161 billion euro of total public funding will be spent between the years 2014-2020. Hungarian Rural Development Programme puts particular emphasis on actions related to restoring, preserving and enhancing ecosystems, promoting social inclusion, poverty reduction and economic development in rural areas and promoting food chain organisations and risk management in agriculture. Within the framework of Rural Development programme 2014-2020, approximately 34 billion from the EU budget and 740 million national co-funding euro is spent in Hungary. Member States must take measures to ensure that subsidies financed by the European Agricultural Guarantee Fund are implemented correctly. Therefore national authorities are required to operate an Integrated Administration and Control System (IACS) in order to ensure correct payments and prevent irregularities. For measuring the efficacy of the policy, several indicator sets are being used as Common Monitoring and Evaluation Framework (CMEF) indicator. The problem is that these indicators are either specific only to beneficiary farms (for example output and result indicators) or very general, like context indicators. Therefore, it is very difficult to compare the performance of farms under a specific programme to a control group. In Hungary, a new Farm Register is being developed. Administrative registers like IACS with around 200 000 beneficiaries are linked to the units in the existing farm register. It is an opportunity to use these new register information and with their help assess the differences in agricultural production methods between farms under agri-environmental measure or organic production and conventional agriculture. It is crucial whether the policy targets are met and their production is more environmental friendly indeed. While it is also important to asses whether there are difference for example in crop yields. The paper describes what kind of administrative and register information might be used in Hungary to evaluate policies even better without the increase of data collection costs and burden on respondents.

T4.3.4: Effectiveness of research-extension-farmer linkages of agricultural technology management agencies in Assam, India (Abstract Id: A4-6-069)

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The Agricultural Technology Management Agency (ATMA) is a district level registered society responsible for technology dissemination in the district. It is an institutional innovation, and one of the objectives of ATMA is to strengthen research – extension – farmer linkages. However, studies on linkages maintained among these three actors in the last few years, found that linkage effectiveness was poor. In case of Assam, to date, scant attention has been paid to linkage effectiveness of ATMA model. Therefore, the purpose of the study was to compare and assess the effectiveness of Research-Extension-Farmer linkages of ATMA. The study was conducted in Jorhat (World Bank- ATMA) and Golaghat (Central Sector Scheme- ATMA) districts of Assam. The multistage sampling design was followed to collect data from 134 respondents. The linkage effectiveness was studied at the Block level. In the study,

Krishi Vigyan Kendra (KVK) was a unit of research; Block Level ATMA was the extension unit and farmers involving with ATMA formed the farmers‟ unit. A method was developed to obtain linkage effectiveness scores. The study found that the overall linkage effectiveness score between Block Level ATMA- Farmers was highest in both the districts. The Mann-Whitney U test indicated that linkage effectiveness score was higher for ATMA-Golaghat (Mdn=15) than for ATMA-Jorhat (Mdn =14), (U=143.1, Z= - 2.897 and p=.486). Kathalguri Block of ATMA Golaghat and Koliapani Block of ATMA-Jorhat scored highest linkage effectiveness score where the KVK of the districts are located on the Block (U= 2.81, Z= -1.202 and p= .423). The study found that the proximity of Block and KVK and inbuilt mechanism at KVK for ATMA activities increase R-E-F linkage effectiveness.

T4.3.5: Use of statistics for policy making and research in Agriculture (Abstract Id: A4-6-067)

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There is wide recognition of the fact that policy and decision making should be evidence based. In most of the cases this evidence is generated with help of official statistics or the statistically robust studies undertaken. Statistics also plays an important in research for acceptance of the findings of any research for it being generally applicable and acceptable. The session would address the following questions. 1. There is a need to set up appropriate mechanisms to have a clear and direct communication between policy makers and data producers. Many mechanisms exist for the purpose specially in the context of identification of specific data needs by the policy makers and production of such data. What are options available? What is the best and most effective system in this context? Should it be seen in the context of overall system of governance in a country? 2. How this process is adopted in the context of development of national statistical development plan? How agriculture statistical system is integrated with the over all statistical plan? Are there mechanisms in place? 3. What is the role played by policy makers in ensuring that the required data production is monitored and the agreed indicators and related statistics are delivered according to time schedule with required level of quality? 4. Is the data generated properly communicated to the policy makers? Is there a specific policy for regularly communicating the generated data? What are modes of such communication? Is data producing agency having necessary capability to effectively communicate data with visual images on geographic maps or using satellite imageries or any other tools required in the context of the question? 5. Is there a mechanism for analysis of the statistics generated to address specific policy issues? These issues maybe specific to a policy question. Agriculture sector has various questions relating to quantity of production, pricing of agriculture commodities, income of farmers, technology adopted in farming and processing of produce, mechanization of agricultural operations etc. Each of these questions require proper analysis from various sources of data for a meaningful policy intervention. The panel would like to address these questions and reflect on how this dialogue between policy makers and data producers can be made effective, meaningful and help in delivering better evidence based policies.

T4.3.6: Using agricultural survey data to support the policy reform process: FAO-MAFAP experience
(Abstract Id: A4-6-016)

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Establishing a solid evidence base is the bedrock for promoting efficient and effective agricultural policy frameworks and instruments. The present work describes the experience of the Monitoring and Analysing Food and Agricultural Policies (MAFAP) programme of the Food and Agriculture Organization (FAO), which relies on agricultural and socio-economic survey data to establish country owned and sustainable systems to monitor, analyse, and reform food and agricultural policies in 14 African and 2 South Asian economies. MAFAP is working with the partner governments to shape policy reforms that are informed by high-quality research-based economic evidence. To achieve this, MAFAP experts work with governments to identify specific policy issues, analyze and assess policy reform options, and return sets of viable solutions and recommendations. The policy areas of MAFAP engagement include the development of strategic/programmatic documents, the optimization of public budget allocation, input subsidies targeting and phasing out, producer price support, optimization of public procurement activities, regulatory issues, and agricultural trade policy orientation. This paper will show how - after receiving specific governments' requests - MAFAP experts exploit available socio-economic and agricultural survey data combined with the most appropriate quantitative and qualitative tools to answer specific policy questions. Methods range from state-of-the-art quantitative analyses based on econometrics and partial/general equilibrium modelling to commodity specific value chain analyses and qualitative assessment based on stakeholder interviews and focus groups. Based on the findings, MAFAP formulates actionable policy reform alternatives, assesses their relative cost-effectiveness and public budget implications, provides recommendations on the best options to pursue and supports the government during the adoption and implementation of the reform. The paper will present also several case studies of successful policy reforms achieved through the analysis of agricultural survey data in Sub Saharan Africa as well as it will discuss those factors favoring the dialogue between governments and international institutions on evidence-based decision making.

Session T4.4: Produce the Data that Matters: Building Policy Responsive Data Systems

T4.4.1: Producing the data needed for policies
(Abstract Id: A4-6-065)

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Good policies are fundamental for agricultural growth. Yet, policies are often based without the benefit of accurate agricultural data. Governments, non-governmental organizations, businesses, investors and others often base policies without reliable information, resulting in sub-optimal decisions. Increasing agricultural production and agricultural income requires a vast amount of different types of information. The paper will discuss different types of data needed by different types of data users and policy makers, and also present different options for producing necessary information.

T4.4.2: Integrating datasets on rice-based agri-food system to enhance policy advice effectiveness
(Abstract Id: A4-6-066)

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The use and implementation of big data and cutting-edge data management systems can greatly enhance evidence-based policy decisions in agriculture. Properly managed big data can help fill existing gaps and provide insightful new information about the impact of most interventions. For example, with big data, it is possible to identify the sources of change and to attribute results. Currently, data types from different disciplines are often collected separately and with a project focus. Full data integration would allow for the big picture to emerge and allow for more powerful analytics to be adopted. For that to happen, one necessary condition is to design and develop a suitable platform to integrate data from different projects and disciplines. Integrating datasets in a one-stop database will provide Findable, Accessible, Interoperable and Reusable (FAIR) data. Such databases could greatly help to answer multidimensional and complex policy questions requiring multiple information sources and combining them in various complementary layers. IRRI has decided to go in that direction. It has developed a database (SurveyStat) incorporating survey data for social and economic sciences in a reliable and systematic way. This database is integrated in an overarching interoperable system designed to connect all the databases of the Institute. The goal is to provide a holistic picture of rice-based agri-food systems realities worldwide. The questions that SurveyStat and associated system helps us to investigate include: 'How many farmers have been lifted out of poverty due to the release of improved varieties globally?'; 'What were the most favorable factors driving the way out of poverty?' 'What kind of farming practices have been the most efficient considering the environmental, nutritional and prosperity trade-offs?'; 'What have been the most successful transformation pathways adopted by the International Rice Research Institute (IRRI) across countries?' Nonetheless, the type of data used and their reliability will finally determine the quality of the evidence generated by policy-oriented research at IRRI and most likely impact the outcome of the policy advisory role that the Institute is increasingly playing. By combining data sources meaningfully, researchers will minimize the risk of measurement errors or inaccurate data and reduce possible liabilities associated with weakly grounded policy recommendations. Recognizing that data and analytics are the foundation for evidence-based policy advice but not the only main component, IRRI has invested in human capacity for data interpretation. A policy advice grounded on good data, adjusted to the context, and provided in a timely manner should determine the usefulness and impact of IRRI's policy support. In this paper, we present IRRI's experience in integrating datasets for the rice based-agri-food systems. We present the key findings emerging from this Institute-wide initiative and draw the lessons that could be used to improve performances during the next iteration. Through a few examples, we show how integrated data have helped improve the quality of policy support. We conclude by indicating the way-forward and noting the gaps that remain to be filled towards achieving the overarching objectives of integrated data on rice sciences for improved policy decision.

T4.4.3: Establishment based statistics on agriculture from economic census 2018 of Nepal
(Abstract Id: A4-6-017)

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Evidence based planning, monitoring and decision making are the key for the success of national development process. It is more evident in those countries where majority of the population are engaged

in agriculture and live in rural areas. A robust statistical set-up is a pre-condition to produce enhanced economic statistics towards achieving the global development agenda within the national scope. Some agriculture statistics are also constituted in the domain of economic statistics. The Agriculture Development Strategy and Sustainable Development Goals are assumed to be the main guidelines of the whole road map of the agriculture sector, which contributes more than one fourth in national GDP. The fifteenth periodic plan of the country has also envisioned to promote the sustainable, competitive and prosperous agriculture-based economy. In this context, a reliable and timely statistical data are very essential to formulate as well as implement the agricultural development policies, plans and programs. In the recent years, the agriculture entrepreneurships have also been grown up in the country which are one of the potential scopes of employment generation and promoting sustained agriculture economy. Although there existed current agriculture from farm based and holding based agriculture statistics through admin data system, agriculture surveys and censuses, there was a need of establishment-based agriculture statistics to supplement the complete statistical scenario of the sector. Hence, Central Bureau of Statistics conducted first national economic census of Nepal in 2018 based on establishment approach of data collection. The First Economic Census 2018 has enlightened the dimension of crop, livestock, forestry and fishing sectors within the scope of International Standard Industrial Classification (ISIC) sectors of all economic activities. The paper will highlight rationale of covering formal agriculture (crop, livestock, forestry and fishing) based establishments, methodology, analysis on number of establishments, employment status, characteristics (gender and other issues) of manager and owner, business operation information, tenure and area of agriculture business place, account keeping practices, general revenue and expenses, compensation of employees, capital information and access to credit. The paper will elaborate the present status of inclusion of establishment base agriculture statistics in the domain of economic statistics and its prospects in Nepal.

Session T4.5: Monitoring and Evaluation of Agricultural Policies within the Sustainable Development Goals in the EU and other Parts of the World

T4.5.1: Data collection needs and indicators development to assess the environmental performance of the CAP and the contribution to the SDGs (Abstract Id: A4-6-039)

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Within the EU, agricultural policies are increasingly performance-oriented and bringing about new demands in assessing results and expected impacts of interventions. In particular when dealing with the environmental impact of the agricultural sector, the policy approach had to incorporate a higher level of environmental and climate ambition and address citizen's expectations for their health, the environment and climate. In addition to this, the contribution to achieving global SDGs added new dimensions to the challenges and opportunities facing the CAP (Common Agricultural Policy), requiring new approaches to indicators' development and data collection to allow for effective, tailored and systematic monitoring and evaluation. The current system for measuring the performance of the CAP is the Common Monitoring and Evaluation Framework (CMEF). It contains 45 context indicators describing general operational environment of the policy, and 166 indicators which are used to determine whether the CAP is achieving its objectives. This system represents already the shift towards a more performance-oriented policy requiring the establishment of a solid performance framework that based on a set of common indicators, allow the Commission to assess and monitor the performance of the policy. Building on this source of evidence (and some opinion surveys), major findings about the current performance of the CAP with respect to its 2013 reform objectives point towards a progress in the environmental contribution of the

policy, but still in the need of major improvements to meet increasing future challenges. Several difficulties have been identified concerning the monitoring and evaluation system itself, as the high number of indicators and sub-indicators, the availability of the data about the agro-environmental, biodiversity and climate related issues, the quality and reliability of this data. New approaches to indicator development and data collection have still to be developed to allow for effective, tailored and systematic monitoring and evaluation. The new focus on policy performance and the more ambitious setting of targets require comprehensive, complete, timely and reliable information on EU agriculture and rural areas. Existing data sources need to be adapted and strengthened to match better with the new policy and new data sources should be explored in order to reduce the burden for farmers and administrations, while at the same time improving policy evidence base. New technologies (satellite base tools) help as well in facilitating this process. The paper will first describe the higher ambition in the policy context in terms of environmental targets. Then, it will focus on the current system of monitoring and evaluation of the policy, highlighting the potentialities and weaknesses related to the reliability and quality of data, to their availability and to suitability of the indicators. Starting from the lessons learned in the current policy period, the paper will present some considerations on how to improve the system of monitoring and evaluation towards a more robust and systematic collection of data and harmonisation of indicators, able to catch the increased environmental performance and the extension of the EU policy targets to include the SDGs.

T4.5.2: Measuring the success of U.S. agri-environmental policies and programs (Abstract Id: A4-6-047)

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Agricultural production affects a wide range of natural resources, including land, water, and air. This paper examines efforts to measure uses of natural resources (land and water) and commercial inputs (energy, nutrients, pesticides, antibiotics, and other technologies) in the U.S. agricultural sector and how they contribute to environmental quality, with a focus on those practices and indicators that are policy relevant. Reflecting broadened public concerns, U.S. conservation programs target multiple environmental quality goals. Along with reductions in soil erosion, potentially measurable goals have expanded to include improved water quality and conservation of wetlands and wildlife habitat. Newer program objectives may include preserving open space, managing nutrients from fertilizers and livestock waste, conserving water, reducing pesticide runoff, improving air quality, soil carbon sequestration, soil health, protecting pollinators and more. Meaningful indicators are those that produce measures of environmental quality status and trends that are comparable across time and space, and that can be linked to changes in farmers' behavior that are induced by policies. The US Department of Agriculture invests six million dollars (U.S.$) per year in programs designed to improve and enhance the environmental performance of agriculture, and thus has an interest in developing an evidence base on the impacts of those programs. At the same time, international efforts to develop agri-environmental indicators are increasingly complex, with an increasing number of indicators and sub-indicators, and are straining data and reporting resources. Lead among these are OECD's agricultural-environmental indicators and the metrics being developed to report on U.N. Sustainable Development Goals (SDGs), particularly 2.4.1 Sustainable Agriculture. Harmonizing and prioritizing alternative approaches to measuring the environmental performance of agriculture could reduce the cost of developing those indicators while also improving their value. Toward that end, this paper will also compare and contrast the U.S., OECD and SDG approaches. In sum, appropriate indicators are: Policy relevant—provide a direct link to both the environmental attributes of concern and the behavioral changes associated with the evaluated program

incentives; Measurable—based on sound science and make use of data that are available or could feasibly be collected; Reasonably priced—cost-effective in terms of data collection, processing, and dissemination; and, Easy to interpret—communicate essential information to policymakers and other stakeholders.

T4.5.3: Monitoring progress to meeting the sustainable agriculture target in the SDGs (Abstract Id: A4-6-046)

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To sustain increasing food demand from a growing population and the economic development of lagging regions, the agricultural sector will need to be able to expand supply, while minimizing its environmental impacts. Moreover, these goals will have to be met under changing climatic conditions and a shrinking and aging labor force in the sector. These ambitions and challenges are embodied in Sustainable Development Goal number 2 ("End hunger, achieve food security and improved nutrition and promote sustainable agriculture") of the 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015. Target 2.4 focuses particularly on sustainable agriculture and states that "By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality". This document summarizes the efforts that OECD countries and Argentina, China, Colombia, Costa Rica, India and Vietnam have made to monitor progress towards meeting target 2.4 of SDGs. It is based on a questionnaire conducted by the OECD during the first trimester of 2019. The questionnaire asks three main questions: 1. Which approach has your country adopted or planning to adopt to report progress in target SDG 2.4 on sustainable food production? 2. What is the status of your country regarding the development of an indicator or set of sub-indicators to measure Target 2.4 of SDGs? 3. Can you please provide the list of all indicators and sub-indicators developed or in process to be developed as well as data sources to create them? The document is divided in two sections. The first section analyses questionnaire responses and compares them against FAO's suggested methods for tracking progress towards target 2.4. The findings of our questionnaire reveal lack of harmonization across indicators planned to use by surveyed countries. First, a few set of countries use sub-indicators that cover all three dimensions of sustainable agriculture (economic, environmental and social). Most countries' set choice reflects only one or two aspects. Second, a few set of sub-indicators use farm surveys as data source (the FAO's suggested source); most are based on administrative data. Third, countries that have defined a single indicator as preferred approach, intend to report the share of organic cultivated land in total agricultural land as the main indicator to report progress. Lastly, and perhaps most importantly, there is surprisingly few coincidences in the sub- indicators used by countries. The second section will analyse some of the most widely cited indicators planned to be used by countries and discusses some of the potential synergies and trade-offs among them.

T4.5.4: Creating a regional monitoring mechanism for sustainable development in Europe – Experiences from Eurostat (Abstract Id: A11-12-011)

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Sustainable development within Europe and globally including sustainable agriculture has been since many years one of the key political priorities of the European Union (EU) and its Member States. Consequently, the EU and its Member States are fully committed to achieving the Sustainable Development Goals (SDGs) of the 2030 Agenda. Eurostat - the statistical office of the EU - has been supporting the sustainability strategy of the EU since 2001 with statistical indicators to monitor progress. The 2030 Agenda provides for monitoring at national, regional and global level, using indicator sets that are adapted to the different levels. The EU as a strong political player in Europe therefore opted in consultation with its Member States for its own monitoring mechanism that is adapted to EU policy needs. Eurostat was mandated with leading the development of the EU SDG indicators, and decided to preserve the success factors of earlier indicator sets: policy relevance, sound statistical quality and maintainability. Therefore, statisticians from Eurostat and EU policy experts have jointly defined the EU SDG indicators respecting the following principles: relevant for key EU policies including agriculture policy; meeting predefined statistical quality criteria; fixing the maximum total number of indicators to 100 to avoid information overload; achieving a balanced distribution across goals (max. 6 per goal) to give equal importance to all goals. Most importantly, only already available indicators were included to avoid that indicators could not be provided for many years due to methodological issues or data gaps. The choice of the EU indicators for Goal 2 'Zero Hunger' illustrates their adaptation to the EU context in comparison to the global set for this goal. While many of the global indicators deal with under-nutrition and its harmful effects, the EU indicators focus on sustainable farming practices and the impact of modern farming on water quality and the environment. A comprehensive communication package for the dissemination and communication of the EU indicators includes traditional statistical tables that are fully integrated into Eurostat's main statistical databank, complemented with dedicated print and on-line publications and communication tools for a range of audiences. Eurostat updates the EU SDG indicators every year and continuously reviews the selection of indicators and their data sources to remain open to methodological and data development. As an example, Eurostat is investigating the use of geospatial information and Earth Observation information for developing new indicators or improving the relevance of existing indicators. Indicators on agriculture are clearly in the focus here.

Sub-Theme T5: Food Security, Poverty, Rural Development and Social Dimensions of Agriculture

Session T5.1: Food Security Assessments

T5.1.1: A method to estimate the variability in usual dietary energy consumption from household consumption and expenditure surveys (Abstract Id: A5-7-026)

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Background: Household Consumption and Expenditure Survey (HCES) data are being increasingly used for food security and food consumption analysis in low- and middle-income countries with no nationally representative individual dietary intake surveys. The FAO relies on HCES data to infer the variability in usual dietary energy consumption (DEC) for estimating the prevalence of undernourishment (PoU) indicator. Food consumption data from HCES represent short-term consumption and have excess variability—just as individual-level data obtained with short-term measures like 24-hour recalls have inflated variability. The FAO Statistics Division has developed a method to estimate the coefficient of variation (CV) in the distribution of usual DEC adjusting short-term consumption for variance inflation. Objective: To analyze the use of a method, developed by the FAO Food Security and Nutrition Statistics team, for estimating the variability in the distribution of usual DEC using HCES data, and to compare it to a standard method developed by the National Cancer Institute (NCI) for individual dietary intake data. Methods: We will use the 2015 Bangladesh Integrated Household Survey, which includes both a household-level 7-day recall and two rounds of a household-level 24-hour recall applied to the same households with information on intra-household food distribution (i.e., individual-level data). The survey is representative at the national (rural) level and seven regions at rural level. For these populations, we will obtain the empirical CV and the CV of usual DEC (after adjusting for excess variability) from household-level data, as well as the CV of usual DEC from individual-level data treated statistically with the NCI-Method. We will analyze the differences in variability estimates between using household level data and individual dietary intake data Results: We expect the CV of usual DEC obtained adjusting the short-term DEC for variance inflation to be much lower than the empirical CV (both from household-level data) and closer to that derived from the NCI-Method applied to individual-level data. This will confirm that HCES food consumption data must be treated statistically for variance inflation. Relevance: The estimation of the CV in the distribution of usual DEC is important for monitoring access to dietary energy and estimating the PoU. Not treating food consumption data statistically may result in inflated estimates of variability in access to food and caloric inadequacy.

T5.1.2: Consumption of food away from home: Trends in asia-pacific and implications for food security analysis (Abstract Id: A5-7-022)

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With over half the world's population, strong economic per capita growth, urbanization and increased rural-urban migration, the Asia-Pacific region saw rapid changes in recent decades. It includes newer trends in food availability, access and consumption. Significant growth in consumption of food away from home (FAFH) has been observed and there are many reasons for it. FAFH has led to growth in obesity and micro-nutrient deficiency and also presents new challenges in collecting data for accurate measurement and analysis of food security and progress towards achieving SDG 2- the zero hunger goal. At present this region is home to more than half a billion (59%) of the world's undernourished people though it produce enough food for all. It indicates that food availability is no longer an issue but food access is and to address this and monitor progress necessities strong policies and actions grounded with comprehensive food data collection and analysis. The Prevalence of Undernourishment (PoU), access indicator of food security is an estimate of the proportion of population facing serious food deprivation and derived from official national-level information on average food consumption, variability in consumption and energy needs. The main source is country's household consumption and expenditure survey (HCES) data. However, survey data fail to cover all food consumption sources and particularly FAFH as these surveys are primarily designed to inform economic policies, not for food security analysis. Dietary diversification has liberated people from an excessive reliance on traditional staple foods and now animal sources foods, fruits and vegetables and heavily processed foods that are high or unknown in calories are getting importance in their diets with positive as well as negative implications for nutritional outcomes. These non-staple foods are accounts for well over half of total food expenditures and creates new challenges in term of data capturing, availability of nutritional conversion tables (NCT) and conversion factor for non- standard to standard units and untimely accurate analysis of food security. In order for food policies to be effective, it is important that all stakeholders, who are involve in food security and other related inputs data collection, compilation, dissemination and reporting progress towards SDG Indicator, PoU are need to aware of and understand the trends across the domains directly or indirectly affect the food consumption patterns. Collectively, the above trends mean that data availability for food security analysis are becoming substantially more complex compared to the past. The future will see further profound changes in food consumption patterns. To estimate PoU to serve the needs of the SDGs will require a significant coordinated efforts along with new and effective ways of capturing more frequent and better data on individual and/or household food consumption with well-designed and harmonized questionnaire. Given, this reality, this paper will contribute to more informed debate for collecting and analyzing food security data.

T5.1.3: Estimating the Prevalence of Undernourishment (PoU) at subnational level with Household Consumption and Expenditure Survey data (Abstract Id: A5-7-027)

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Background: The FAO Statistics Division has developed a methodology to estimate the prevalence of undernourishment (PoU) in a population, which is one of the two indicators for monitoring progress on Target 2.1 of the Sustainable Development Goals (SDG). Within the SDG framework, there has been a call to disaggregate SDG indicators at sub-national levels such as regions to ultimately leave no behind. Objective: To estimate the PoU at regional level and examine how a national PoU estimate based on the subnational PoU values compares to a national estimate based on the full sample, using Household Consumption and Expenditure Surveys (HCES). Methods: We used food consumption data from over fifty countries with representativeness at national and regional levels. Assuming a log-normal distribution of usual dietary energy consumption, we estimated two parameters of the distribution (for each region and for the full sample): the mean and the coefficient of variation (CV). The latter was adjusted for variance inflation due to measurement error and seasonality. The adjusted CVs were obtained using a method developed by FAO Statistics Division. PoU estimates were obtained for each region, and at national level (one based on the full sample and another based on the regional estimates). We then compared the two national PoU estimates. Results: In most countries, the PoU at national level estimated based on regional PoU values converges with the national PoU based on the full sample. Thereby the results confirm that subnational estimates of the PoU (for which a HCES has representation) are robust. Conclusions: It is possible to produce subnational estimates of the SDG indicator 2.1.1 using HCES data.

T5.1.4: The question of access: Using of official data for food security analysis (Abstract Id: A5-7-015)

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National Statistical Offices (NSO) undertake Household Budget Surveys more or less regularly. The surveys' main purpose is to estimate consumption, which is used to construct the baskets for CPI and estimate material welfare and poverty status. The food consumption module in the HBS asks in detail about quantity and value of all foods consumed as well as how the food was sourced. This well of information is traditionally underutilized for food security analysis. To make such data more relevant the Inter Agency Expert group on Food Security, Agricultural and Rural Statistics has developed a guideline on how to design food consumption modules to accommodate both poverty and food security analysis. The guideline was adopted at the UN Statistical Commission in 2018. The title on this presentation plays on different types of access: The first is the focus on access to food – which is one of the four pillars in food security (the other pillars being availability, utilization and consistency). The second is the access to statistics, which is about results being published in a format that is useful for the users and in a place where users will find it. The presentation argues that the NSO should be the one preparing HBS information on diet composition and how people source their food. Compared to the current practice, where the NSO prepare poverty but not food security statistics, we argue that this approach has several

advantages: It would be more efficient, give better data quality and strengthen the NSO as the provider of food security statistics. Statistics on household's food access, coupled with poverty and livelihoods information in the same household, would be readily available for government and other agencies working on the ground. Statistics Norway and Central Bureau of Statistics (CBS) in Sudan has demonstrated the approach using the Household Budget survey data from Sudan 2015. The data was prepared with the focus to provide both poverty and food security statistics at the same time. In the previous survey in 2010, preparation of food security statistics was undertaken after data was released and outside of the CBS. This presentation will document some of the experiences from Sudan, showing how this approach to preparing the data affected efficiency and quality. It will illustrate how the joint analysis provides an enriched understanding of food security and poverty.

T5.1.5: Prevalence of undernourishment in Indian states: Explorations based on NSS 68th round data
(Abstract Id: A5-7-012)

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Prevalence of Undernourishment (PoU), a measure developed by the FAO, is the main indicator used for measuring global SDG targets on hunger and food insecurity. Estimates of PoU are exceedingly important for prioritizing the national food security policies and for assessing the progress towards the global ambition to end hunger. Given the complexity of measurement of dietary intake and requirements, and given the limitations of availability of data across countries, FAO's model for estimating PoU presents a conceptually sound method for estimating the prevalence of dietary energy deficiency. However, over the years, FAO's methodology of estimation of PoU has been a subject of much debate. The paper suggests some important modifications in the estimation of the distribution of average calorie intake and the average minimum dietary energy requirements to deal with the major criticisms. There are three major contributions of this paper. First, the paper presents an improved method of accounting for out of home food consumption and food consumption by partakers. Secondly, the paper presents a new method of accounting for variations in activity levels of persons engaged in different occupations for the estimation of average dietary energy requirement. Thirdly, the paper uses consumption survey data for sub-national estimation of PoU. This is particularly important in the context of monitoring of Target 2.1 of the 2030 Sustainable Development Agenda, for which the Prevalence of Undernourishment is the globally accepted indicator. Given this, it is going to be necessary for countries to generate sub-national estimates of PoU for monitoring progress towards this target. Using data from the 68th round of NSS surveys and the revised methodology, the paper shows that the problem of undernourishment in India is much bigger (39 per cent or 472 million persons) than what is currently estimated to be (15 per cent or 190 million persons). There are two main reasons for why these estimates are higher than the official estimates published by FAO. First, the estimate of mean per capita consumption based on consumption surveys is 320 kilo-calories less than the estimate based on food balance sheets. This accounts for a 9 percentage point increase in PoU. Identifying sources of this discrepancy and finding ways to reduce the gap is an important direction of future work. Secondly, introducing variations in dietary energy requirements according to differences in physical activity levels results in an increase in average minimum dietary energy requirement, and consequently, an 8 percentage point increase in PoU.

Session T5.2: Food Insecurity Experience Scale

T5.2.1: Prevalence and severity of food insecurity in selected Indian villages: An application of food insecurity experience scale (Abstract Id: A5-7-013)

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Experience-based measures have been the most important innovation in the last two decades in the area of measurement of prevalence of food insecurity. Going beyond the traditional measures based on consumption of dietary energy, experience-based measures better capture lack of access to adequate and nutritious food, and provide tools that allow a probabilistic but highly disaggregated measurement of food insecurity. FAO's Food Insecurity Experience Scale (FIES) is the gold standard in the area of experience-based measurement of food insecurity and provides a global standard scale for measuring severity of food insecurity on a comparable scale. The FIES is estimated using a set of questions that are posed to a sample of individuals. Each question is designed to ask the respondent whether, over the reference period, they have experienced a particular situation – for example, having had to skip a meal or consume inadequate quantity of food – because of lack of money or other resources. These experiences are associated with different degrees of severity of food insecurity. Assuming that a person facing a high degree of food insecurity is likely to answer questions regarding moderate degrees of food insecurity in the affirmative, the tool allows for endogenous estimation of degree of severity associated with each experience as well as the severity of food insecurity faced by every individual in the sample. This paper uses FIES to estimate prevalence of food insecurity in selected villages in four States of India namely Jharkhand, Andhra Pradesh, Haryana and Madhya Pradesh. Although purposively selected for case studies, these villages are very diverse in terms of socio-economic conditions of households. The villages vary in terms of social composition, nature of agriculture, physical access to markets, access to food from forests and other common property resources, and access of households to non-agricultural employment. The four States have very different record of implementation of social protection programmes. Data for this paper were collected through stratified sample surveys conducted in the selected villages. FIES data were collected from a randomly selected member of each sample household. Apart from data on FIES questions, the primary surveys collected information on basic demographic characteristics of the household, sources of livelihoods, landholding, income, asset holding and access to credit. The surveys also collected information on consumption of major food items and the extent to which they obtained food from social protection programmes such as the Public Distribution System, the Mid-day Meal Scheme and the Integrated Child Development Scheme. After testing the statistical validity of these estimates, the paper analyses variations in prevalence of food insecurity across villages, States, social groups, gender and different economic classes of people in the study villages.

T5.2.2: Differences in the food insecurity status of men and women across the world (Abstract Id: A5-7-021)

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The latest FAO global report on food security and nutrition (SOFI 2019, upcoming) shows that, globally, women are more likely than man to be affected by moderate or severe food insecurity. Measures of food

insecurity are obtained by FAO using the Food Insecurity Experience Scale (FIES), which is an experience-based metric of severity of food insecurity that relies on people's direct responses to eight questions regarding their access to adequate food. The analysis of FIES data using the methods developed by FAO produces estimates of the proportion of the population facing food insecurity at different levels of severity that can be made internationally comparable. Thus, they can be used to compile regional and global, as well as national and sub-national, estimates of SDG indicator 2.1.2 ("Prevalence of Moderate and Severe Food Insecurity based on the FIES"). Data used to estimate the prevalence rates presented in this paper were collected by Gallup Inc. through the Gallup World Poll (GWP), on behalf of FAO. The GWP surveys include approximately 1000 individuals aged 15 years and older each year in over 140 countries. Samples are drawn according to a complex survey design to be proportional to the population in each of a number of strata. Post-stratification weights are provided to project the results to the national population of reference. Being data at individual level, they provide a unique opportunity to explore gender differences in accessing food. This paper aims at examining the trends and drivers of gender differences in food insecurity from 2014 to 2018. Preliminarily, to test whether part of the difference in observed food insecurity levels between women and men could be attributed to the fact that they experience in a different way the same food security conditions, we study the differential item functioning (DIF) of each of the FIES questions between men and women. At regional level, we describe where such gender differences are larger and highlight where the gender gap is reducing in time. At individual level, by pooling together data for all available countries and years, we apply a logit regression model to explore the magnitude of the gender gap in accessing food once controlling for a number of individual and household characteristics. Interaction terms with gender are also included to assess in which contexts gender gap is prominent. To better qualify the drivers of gender differences in food insecurity, the logit-modified Blinder-Oaxaca decomposition is adopted, allowing to divide the gender effect into a part that is explained by the differences in observable individual characteristics (i.e. income, education, age) and a residual part. Finally, we study the role of a series of developmental indicators (such as poverty, unemployment, inequality, freedom, corruption or infrastructure) in the gender gap in accessing food at country-level, in order to assess the macro drivers of such gender inequalities.

T5.2.3: Limits to assess food (in) security using the FIES approach: An empiric evidence from a study case in Cameroon (Abstract Id: A5-7-018)

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This paper introduces our contribution to the ongoing debate on food security, answering to a silly but critical question: is "food insecurity" the opposite of "food security"? The problem derives from a general remark that is, in many official reports, the two terminologies are used symmetrically, with no specific accommodations from one use to another, while there is no formal definition for the first item. In fact, at the World Food Summit (2009), the international community agreed to define food security as a situation "when all people, at all times, have physical, social and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". According to the State Of Food Security And Nutrition In The World (SOFI 2017), there were still more than 821 millions of people undernourished, most of them found in sub-Saharan Africa, South Eastern and Western Asia countries. Moreover, this number is said to have increased by 5.6% compared to the previous year (777 millions in 2016), and the number is still to increase over the coming years, if things are not changed.

Such a disappointing evaluation would discourage efforts consented to fight against hunger worldwide. In this context, one can legitimately ask the question: "will we be close to SDG2#ZeroHunger at time?" To answer the question, there were two possible ways; on the one hand we could have checked the sincerity and the pertinence of field interventions deployed by all humanitarian NGO and financial sponsors, asking if they are really willing to eradicate hunger. But rather than exploring this option (due to some overwhelming conclusions expected), we deeply analyzed on the other hand, the consistency and the robustness of one of the statistical tools, nominally the Food Insecurity Experience Scale (FIES), used to estimate the severity of people's food insecurity (recorded as the number of undernourished in official publications). Our first statement follows: how is it that an indicator reporting on "insecurity" is used to measure "security"? We examine this inconsistency through a review of literature which describes the FIES as a rapid and comparative approach to measure food insecurity in different contexts. Due to the complexity to capture all dimensions of food security (given the conceptual definition) into one single indicator, FIES was intended to promote the link between different major sectors involved into food and nutrition security. Assuming this, its contents would have consisted of independent items, each of them addressing one specific dimension, so as to allow multidimensional analysis. Our second statement is that the hypothesis of independence is not verified at all. We demonstrate the redundancy at 85% of information collected through the eight questions asked into the FIES questionnaire, using descriptive statistics, the Chi-squared test and the Rash model (1960). Data were extracted from the 2nd Food Security Monitoring System (FSMS) survey in Cameroon, supported by the World Food Program and the Ministry of Agriculture and Rural Development in 2018.

T5.2.4: Household vulnerability on food security in Niger (Abstract Id: A5-7-032)

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This article studies the households' vulnerability on food insecurity. It makes possible to see the determinants of vulnerability to food insecurity in Niger. On the other hand to find the opportunity for reinforce the households' resilience vis-a-vis this shortage. The study uses the linear regression model (OLS), inspired by the study made by Randriamiandrisoa and Ballet in 2014. The data are from the agricultural ministry (ECVM/A 2015) and the sample size is 9,354 households on national areas except Agadez region. Variables such as: number of land parcels, number of animals, own production, sale of land, sales of assets, secondary activity, sale of animals, migration, number of children aged from 5 to 10 and gender of the household's head, are the households' resilience factors in food insecurity. On the other hand, variables such as shock, off farm labor, number of children aged below five, are households' vulnerability factors. The study shows that the households of Niger are vulnerable to food insecurity. To reduce this vulnerability, it is significant to stress the households' characteristics which make them resilient. For that, the government must ensure a permanent follow to predict the risk of insecurity and to limit its consequences of food insecurity.

Sub-Theme T6: Sustainable Agricultural Production and Consumption

Session T6.1: Measuring Sustainable Agriculture Production

T6.1.1: The farm survey as the preferred data collection instrument for SDG 2.4.1 (Abstract Id: A6-8-019)

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This paper summarizes the data collection strategy that FAO has put forth for SDG indicator 2.4.1. "Proportion of agricultural land under productive and sustainable agriculture" with the aim of facilitating national data production and reporting in more than 50% of countries by 2030. This paper describes the FAO overarching data collection strategy and the encompassing action plan between 2019 and 2030, to enable member countries measure, monitor and report the productivity and sustainability of their agricultural farms in a harmonized and internationally comparable way, both for national policy making and international reporting. The 2.4.1 methodology requires countries to collect a range of social, economic and environmental data across eleven sub-indicators. Farm surveys are the suggested tool for national reporting on 2.4.1, requiring in principle the implementation of a single, coherent data collection instrument that is fully integrated with the Agricultural Census. To this end, novel FAO survey programs, such as the "Agricultural Integrated Survey" (AGRIS), soon to be integrated within the ''50X2030 Initiative,'' are specifically designed to support countries to collect via farm-level surveys information across the three dimensions of sustainability relevant to 2.4.1, including through customization of their existing farm surveys.

T6.1.2: Measuring agricultural sustainability in Vidarbha region of Maharashtra (Abstract Id: A6-8-030)

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In this study, an attempt has been made to measure the Sustainability of Agriculture in Vidarbha region of Maharashtra state and to identify the factors responsible for sustainability. The sustainability is measured by developing Sustainability Index of Vidarbha region with the help of various indicators of sustainability. The study was based on secondary data of area, production, productivity, population, agricultural population, weather, irrigation, area under high yielding varieties were collected from various Government publications of Maharashtra. The data for computation of indicators cost-benefit ratio for selected crops were adopted from the records of Agricultural Prices Cell (APC), Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The data pertain to a period of 38 years i.e. from 1980-81 to 2015-18. The study was limited to the principal crops namely cotton, kharif jowar, soybean, tur, gram and sunflower cultivated in Vidarbha. The result showed that the sustainability index developed through principal component analysis was seen declining over the years. The Sustainability index ranges from-0.308 to 0.350. Higher number of sustainability index represents higher sustainability whereas, lower number represents lower sustainability. This concludes that the Vidarbha agriculture is slightly sustainable with a tendency to deteriorate with time. The study also found that the productivities per hectare of cotton, tur,

kharif jowar, sunflower and gram, gap in gross returns in cotton, kharif jowar and gram, cost-benefit ratio of cotton, kharif jowar and gram, parity index of kharif jowar and gram, availability of land per farmer, ratio of irrigated land to irrigable land, per capita production of foodgrains, ratio of agricultural population to total population, area under high yielding varieties and rainfall were the significant contributing variables for agricultural sustainability of the Vidarbha region. Key words: Sustainability indicators, Principal Component Analysis, Sustainability Index, Mann Whitney U Test)

T6.1.3: Global analytical framework for the multi-dimensional assessment of agroecology (Abstract Id: A6-8-013)

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Agroecology is a science, a practice and a social movement. While there is already much evidence on the contribution of agroecology to sustainable agriculture, these results remain fragmented because of heterogeneous methods and data, differing scales and timeframes, and knowledge gaps. After leading the process of global and regional mutistakeholder consultations on agroecology, FAO has proposed and developed a Global Analytical Framework for the multidimensional assessment of Agroecology and has started testing it. The objective of the framework is to produce evidence on the performance of agroecological systems across the various dimensions of sustainability to support policy making processes. The framework is composed of the 3 following steps: - Step 0. Classification of systems and context This preliminary step includes a description of the main socio-economic and demographic characteristics of the systems such as location, household size, possession of productive assets, access to land, etc. It also includes a description of the enabling environment in terms of relevant policy, market, technology, socio-cultural and/or historical drivers. - Step 1. Characterization of Agroecological Transition (CAET) Step 1 consists of characterizing the systems using the 10 Elements of Agroecology proposed by FAO (2018). Semi-quantitative indices or descriptive scales are used to establish scores. For example, the indices of the element ´Resilience´ are (i) Stability of income and production, (ii) Diversity of activities and products, (iii) Mechanisms to reduce vulnerability, and (iv) Degree of financial indebtedness. The scores of the four indices are summed and the totals are standardized on a scale from 0 to 100% to obtain the general score for the particular element. The same method is applied to all 10 elements to create a unified view of the degree of agroecology of the system. Step 1 can be completed as a self-assessment by farmers or carried out by technicians, scientists or government agents in partnership. Results are presented in a radar-type diagram which allow the identification of strengths and weaknesses and entry points for enhancement. - Step 2. Core Performance Criteria/Indicators This step consists of assessing indicators of performance of agroecological systems on the key dimensions considered relevant to address the Sustainable Development Goals (SDG): Environment & climate change; Health & nutrition; Society & culture; Economy and Governance. The consultation process led to the selection of the 10 following criteria for measurement: Soil health, Agrobiodiversity, Dietary diversity, Exposure to pesticides, Women's empowerment, Youth employment opportunity, Net income, Income distribution, Productivity and Secure land tenure. Simple indicators that can be collected in a farm-level survey were identified for all 10 criteria, some corresponding to SDG indicators of sub-indicators (e.g. Agrobiodiveristy). Results are also standardized for each indicator to allow comparison. The core indicators can be complemented by advanced methodologies relevant to the specific framework or inference of assessment interest. For example, tools can be used to estimate greenhouse gas emissions and complement the core indicators to give an overarching view of the contributions of agroecology to particular interests. Preliminary data from tests in different countries and systems have been collected and analyzed.

T6.1.4: Proportion of agricultural area under productive and sustainable agriculture in Bangladesh
(Abstract Id: A11-12-007)

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Sustainable Development Goals (SDGs) is the agenda of 2030 built on the 15-years horizon of the 21 anti-poverty targets established in 2000 by the eight Millennium Development Goals (MDGs). What the SDGs aim to accomplish is to pick up where the MDGs left off and it is the collection of total 17 goals set by the United Nations General Assembly in 2015. To facilitate the implementation of the global indicator framework and overall monitoring, 169 targets as well as 232 indicators were created across these goals. Bangladesh integrated these 2030 Agenda in its 7th Five-Year Plan (FYP) (2016-2020). This provided a tremendous opportunity to implement the 2030 Agenda, while reflecting the priorities of the SDGs in the national plan. SDG indicator 2.4.1 under target 2.4 of goal 2 is the "Proportion of Agricultural Area under Productive and Sustainable Agriculture". On 27 November 2018, this indicator was reviewed at 8th IAEG-SDG meeting and it was reclassified from Tier III to Tier II after developing an approved methodology for this indicator. To facilitate the methodological development as well as to test the practical applicability of the designed methodology of the indicator, FAO has conducted the exercise of pilot testing for several countries. In response, Bangladesh Bureau of Statistics (BBS) was proposed to take participate in the pilot testing and test the practicality of this agricultural module surveys. As part of the pilot testing of the SDG indicator 2.4.1, first step was completed according to the FAO guided activities which was the administration of a field survey of 30 samples (15 farms and 15 households) for cognitive test. The survey was conducted in six different Upazilas of Mymensingh District, namely Bhaluka, Dhobaura, Fulpur, Tarakanda, Mymensingh Sadar and Muktagachha. After the completion of cognitive test, a report was submitted to FAO. The report explains the practical applicability of the FAO designed questionnaire in the context of Bangladesh, also question-wise comments and recommendations were submitted to FAO for further improvement. After completion of field survey for cognitive test and report submission, the same questionnaire was finally used for field survey of extended test that was aimed to facilitate the measurement of sustainability of this indicator in Bangladesh. Total 360 households and 60 farms were surveyed from 4 different Districts of the country, namely Jamalpur, Jashure, Dinajpur and Maulvibazar. The collected data is now under the process of further analysis and very soon it will be able to reveal a picture of sustainability of this indicator in Bangladesh, which will be the first country to report on the indicator.

Session T6.2: Food Loss Assessment

T6.2.1: Measurement of post-harvest losses in Malawi
(Abstract Id: A6-8-009)

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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.

T6.2.2: Measurement of pre-harvest losses due to pests: a literature review and proposal of new assessment methods (Abstract Id: A6-8-023)

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Countries around the world as well as regional and international organizations emphasize the need to increase crop yields to feed rising populations. African Heads of State set quantitative productivity targets, with a commitment to "accelerate agricultural growth by at least doubling current agricultural productivity levels by the year 2025" (Malabo Declaration, June 2014). The reduction in losses due to pests before the harvest is the key to fulfilling this objective. Judging by the differences in crop yields across regions, the magnitude of pre-harvest losses due to technical inefficiencies in crop production, such as insufficient or inappropriate pest control measures, is likely to be large. There is a large body of research investigating the incidence of pests, weeds and diseases on yields and the efficiency of crop protection practices in reducing the related losses. However, the measurement approaches, the data collection protocols and the scope tend to vary from one study to another. Very few studies have tried to provide aggregated estimates of the incidence of pests on crop yields. Cramer (1967) has been the first to provide comprehensive global estimates for several crops, followed much later by Oerke (1994) and Oerke (2006). This Literature Review seeks to identify the measurement frameworks able to produce statistically sound statistics on pre-harvest losses, which could be used as a benchmark by the international community as well as a starting point for additional methodological and empirical work. This work also seeks to identify the major measurement gaps and outline options for improvement as well as possible additional research needs. To fulfil these objectives, there is the need to: i) Screen the recent evidence on pre-harvest losses due to pests and characterize the measurement frameworks most commonly used, with a specific focus on country or region-wide assessments; ii) Assess the measurement methods with respect to their ability to produce statistically sound data on pre- harvest losses at country and global levels, and iii) Identify the gaps in the existing global estimates and propose new measurement approaches or improvement of existing ones This article is structured as follows: after defining the main concepts, Part 2 describes and assesses the main approaches used to measure pre-harvest losses, from the field or farm-level to the compilation of global estimates. Part 3 succinctly presents trends of pre-harvest losses due to pests at regional or global levels for different groups of commodities. Taking stock of the gaps identified in Part 2 and 3, Part 4 outlines possible options to improve the coverage and quality of the quantitative information on crop losses. Among these options, a possible econometric model is outlined that could generate quick estimates of pre-harvest losses due to pests based on existing international data

sources. The fifth and final part concludes, identifying the possible next steps. References are listed in Part 6 and Annexes presented in Part 7.

T6.2.3: Pilot Test on Estimation of Food Loss in Fruits and Vegetables, Mexico Experiences (Abstract Id: A6-8-001)

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It is estimated that every year, one third of the food produced in the world, equivalent to 1300 million tons, end up as waste in the containers of consumers and retailers, or spoil due to poor practices of transport and harvest (FAO). In this sense, the production and distribution of food represents a global challenge to ensure sustainable practices in the various production, distribution and consumption channels. To respond to this challenge, the UN established, within the Sustainable Development Goals (SDG), the SDG 12 "Responsible consumption and production ", from which goal 12.3 is derived: "By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses". FAO is the custodian UN agency for this indicator. Thus, FAO has developed the methodology for the measurement of the food losses in order to serve as a global reference and comply with the ODS indicator 12.3.1 "Global Food Loss Index ". In Mexico, the National Institute of Statistics and Geography (INEGI) has promoted the measurement of the SDGs indicators, especially the measurement of food loss. To this end, the INEGI has promoted the data collection on food losses through the National Agricultural Survey (ENA). In mid-2017, the INEGI and FAO established a collaboration to strengthen the measurement of food losses, from which, technical meetings and a series of field visits were developed during the processes of stakeholder consultation and field practices. As a result of the collaboration, INEGI and FAO carried out the pilot test of the methodology developed by FAO, for the measurement of food loss, specifically in fruits and vegetables, which was held in Mexico in September 2018. Derived from the pilot test and the recommendations issued, the ODS indicator 12.3.1, changed from the Tier III to Tier II classification, and the methodology proposal was approved, which could be implemented by the others countries. Finally, INEGI will present the results and experiences obtained in the pilot test, wich allow the improvement in the desing of the questionnaire and the metodology that FAO proposed for the mesurement of indicator 12.3.1.

T6.2.4: Update on estimating food loss and food waste along the U.S. food supply chain (Abstract Id: A6-8-018)

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In the United States, there have been several efforts to estimate food loss and/or waste in order to understand the magnitude of the problem. This presentation will primarily provide an update on the efforts underway to improve the estimation of food loss by the U.S. Department of Agriculture's Economic Research Service (ERS), which uses their Loss Adjusted Food Availability (LAFA) data series to estimate food loss at the retail and consumer levels in the United States. ERS defines food loss as the edible amount of food, postharvest, available for human consumption but not consumed for any reason. Food loss includes factors such as loss from mold, pests, or inadequate climate control, cooking loss and natural shrinkage (e.g., moisture loss), and food waste (e.g., food left on a plate). Food loss occurs for many reasons, with some types of loss—such as spoilage—occurring at every stage of the production and

supply chain. Between the farm gate and retail stages, food loss can arise from problems during drying, milling, transporting, or processing that expose food to damage by insects, rodents, birds, molds, and bacteria. At the retail level, equipment malfunction (such as faulty cold storage), over-ordering, and culling of blemished produce can result in food loss. Consumers also contribute to food loss when they cook more than they need and throw out the extras. There are good economic reasons for some food loss, such as to ensure food safety. ERS estimates that in 2010, a total of 133 billion pounds, or 31 percent, of the 430 billion pounds of available food supply at the retail and consumer levels went uneaten, with an estimated retail value of $162 billion. On a per capita basis, this totaled roughly 1.2 pounds of food per person per day, with a retail value of over $1.40. ERS's LAFA data series is considered to be preliminary because the agency continues to improve the underlying assumptions and documentation. In particular, this presentation will provide updates on the following ERS initiatives underway to improve the food loss estimation methodology and the underlying food loss shares: (1) review of new estimates of consumer-level food loss, (2) adoption of select recommendations from an 'Expert Panel on Technical Questions and Data Gaps in the ERS LAFA Data Series', (3) an ongoing study to update retail level loss factors for select LAFA commodities, and (4) progress on a ERS farm-to-retail food loss project. The objective of this fourth project is to develop a deeper understanding of food loss in fruit and vegetable markets at the farm and pre-retail sectors and the economic drivers that impact loss in these sectors. Such information could help create new markets for cosmetically imperfect food, value- added products, or other business opportunities for farmers. This presentation will also provide a general update on two major sources of food waste data in the United States: the estimation of food waste by the U.S. Environmental Protection Agency (EPA), and by ReFED, which is a multi- stakeholder nonprofit organization.

T6.2.5: Food loss measurement & learnings accrued: Impact evaluation experience across three value chains in Kenya, Tanzania, and Nigeria (Abstract Id: A6-8-017)

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Yieldwise is an initiative of the Rockefeller Foundation whose goal is to reduce post-harvest losses by 50% in mango, maize and tomato value chain and improve millions of rural lives. The Initiative was implemented from 2015 to 2019 and covered three African countries Kenya, Tanzania, and Nigeria with a focus on mango, maize and tomato respectively. Implementation was carried by a different partner in each of the countries. In Kenya, TechnoServe worked in mango, and the Alliance for a Green Revolution in Africa focused on Maize in Tanzania, and finally, in Nigeria Pyxera Global implemented the intervention with focus on Tomatoes. In this presentation, we will highlight experiences in executing the impact evaluation and learning process for the initiative and measurement of key indicators of interest. The initiative design embraces learning for adaptive management and strategic decision making as critical process for success . Thus, we will give a brief overview of learnings contributed to adaptive management. We will then zoom in on challenges and lessons learned from evaluator lens throughout the life of the program. These challenges include issues such as aligning data collection with crop cycle, data availability and limitations, instrument design, survey data collection, local capacity, managing a panel sample for many rounds of data collection, recall bias effect on postharvest loss estimates, Lack of protocols to measure post-harvest loss estimates in different points of the value chains, etc. All of these challenges varied between and across countries and crops which required a special analytical approach to evaluate the initiative at the higher level compared to individual evaluation efforts conducted within each country. Then we would finally show some of the main finding and results of the initiative. From the implementation of the impact evaluation, we have learned that 1) data collection has to be undertaken just

after harvesting to minimize recall bias, 2) To be able to show impact of the interventions, a panel sample of treatment and comparison farmers has to be maintained, 3) The post-harvest loss measurement methodology at farm level is different with the methodologies for measurement at other points of the value chain and 4) surveys contracted to collect and analyze the data have different capacities which has an impact on the quality of the data and thus on the impact evaluation findings.

These learnings have enabled the initiative to adaptively manage and make changes to the methodologies used for postharvest measurement at all points of the value chain, contracting of competent survey firms and managing panel samples of treatment and comparison farmers. Finally, through impact evaluations we have seen an average post-harvest loss of between 20-30% in the three value chains.

Session T6.3: Sustainability Assessment of Agriculture; Sustainability Indicators; Bio-Physical Indicators, Socio-Economic Indicators, Ecosystem Valuation

T6.3.1: Climatic anticipation of dry cereal producers in the groundnut basin of Senegal (Abstract Id: A6-8-028)

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Description of the subject. The Groundnut Basin is one of six (6) agro-ecological zones in Senegal where farmers are more affected by climate uncertainty in rainy season (Republic of Senegal, 2015a). Objectives. This paper examines the types of climatic anticipation of dry cereal producers before wintering begins. Method. A survey is conducted randomly with 545 farmers in three regions: Louga, Kaolack and Fatick. The main parameter used for determining types of anticipation is based on climate information. Farmers are classified according to their ability to formulate a climate forecast; then, from the source of their anticipations; and finally, trust in the main (reference) source of information. Results. The results show that the majority of producers formulate adaptive expectations, ie 35.41% and only 1.65% makes expectations without a formal source. These results could lead to a better understanding of the behavior of agricultural producers in the face of climatic uncertainty in semi-arid zones. Conclusion. The existence of several sources of climatic information poses the problem of trust in each source. It is then a question of integrating the local knowledge in the activities of sensitization of meteorological information.

T6.3.2: Sustainable development of agriculture in Russia on the basis of inclusiveness (Abstract Id: A6-8-004)

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The research considers the relevance of the development of a multi-faceted economy of agriculture on the basis of inclusiveness. The lack and uneven distribution of state support in favor of large investment projects have led to a reduction in the resource potential of more than half of the regions of Russia, to constrain the development of a multi-faceted agricultural economy, and to increased degradation of rural

areas. In a situation where the process of ensuring food security is largely completed, it is necessary to reorient the state agricultural policy to a small producer – peasant (farm) households and households of citizens. This does not mean that it is necessary to abandon the implementation of large projects, however, a small producer has the prospect of parallel development, especially in the context of sustainable development of Russia. Taking into account international experience, an inclusive economic model is a promising area of development. An inclusive approach involves ensuring equal access for agricultural producers to economic development opportunities and unhindered interaction between them and the population of a particular rural area. Inclusiveness will improve labor productivity, environmental friendliness, and digitalization of Russian agriculture. The transition to an inclusive model should be provided by a system of indicators that make up the rating (index) of inclusive development. This research proposes a system of indicators of inclusive development, consisting of 22 indicators, united in four groups. The first group of indicators characterizes the growth and development of the agricultural economy. The second group of indicators characterizes the inclusive development of the agricultural economy. The third group of indicators characterizes the reproduction of the rural population and the sustainable development of agriculture. The fourth group of indicators describes the development of the digital economy of agriculture and rural areas. The rating (index) of inclusive development of agriculture economy of Russian regions is constructed on the basis of the system of indicators. Typical groups of regions differing in the level of inclusiveness development are identified. Each of the typical groups of regions is characterized by a system of indicators. These indicators allow revealing reserves of development of the economy of agriculture of Russia. Regions with a high level of inclusiveness in the development of the agricultural economy have a higher volume of production, a level of labor productivity and development of information in rural areas. The share of peasant (farm) households and households of citizens in the production of major agricultural products is also high. In regions with a higher level of inclusiveness, peasant (farm) households and households of citizens are larger than in regions with a lower level of inclusiveness. Inclusion will minimize the impact of uneven agricultural development and provide hidden reserves of economic growth to achieve sustainable development goals. The rating (index) of inclusive development can be an effective tool for assessing and monitoring the changes needed in the agricultural economy. Also, the rating (index) of inclusive development can become a more equitable approach to assessing the prosperity of agriculture and rural areas of Russia.

T6.3.3: Agriculture and ecosystem services: Synthesis of issues and way forward (Abstract Id: A6-8-006)

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The contributions of Indian agriculture in ensuring national food security, improving livelihood of rural poor and reducing poverty are well documented. Of late, there have been concerns about rising environmental costs of agricultural development, mainly because of indiscriminate use of natural resources like groundwater, erosion of soil and biodiversity. Therefore, sustainability and resilience of agricultural production systems have gained importance for future growth. The global recognition of the UN sustainable development agenda of SDGs with specific targets directly related to agriculture are getting increasing attention of researchers and policy makers. Agriculture as a man-made ecosystem provides as well as relies upon services of natural ecosystems. Understanding ecosystem services provided by agriculture is complex as the interaction between agriculture and its ecosystem is bidirectional. It is, therefore, important to understand ecosystem services provided by different agro-ecosystems and quantify them for prioritizing investment decisions and development of institutional frameworks for incentivising the people who are generating these services. However, the interactions and contributions to ecosystem services vary considerably because of wide diversity in agricultural ecosystems, arising mainly due to differences in cropping systems and environment. Understanding of

these issues becomes easier when multi- functionality characteristics of agro-ecosystems is taken into consideration and economic, ecological and social dimensions are given due emphasis. This paper aims to collate empirical evidences on ecosystem services, assess role of R&D in enhancing them and mainstreaming ecosystem services in the development processes. The ecosystem services were quantified using various methods like market value approach, contingent valuation method, benefit transfer approach, travel cost method, preventive expenditure and productivity change method. Case studies on biodiversity, wetland ecosystems, and services from soil and water conservation programs, soil amendments, and agro-forestry systems quantify the value of ecosystem services in either monetary or physical terms. The paper discusses various sustainable technologies and practices (biological amendments, conservation agriculture), investments and agricultural policies for increasing the flow of services. Agro-forestry system is of great economic significance to farmers and it also reduces carbon emission. The value of carbon sequestration in soil by agro-forestry ranges from US$ 1,778 to US$ 4,673 (2017 prices) depending upon nature, density and age of plantation. The value of services from traditional conservation methods like sacred groves is estimated at US$ 14 for use and US$ 1.74 for existence value. Water quality improvements from forest ecosystem estimated through hedonic pricing method was $0.40-1.20 per household per year at 2004 price levels. Sand dune stabilization in arid- ecosystem resulted in improved nutrient cycling (US$ 221 per ha) and carbon storage (US$ 18 per ha). The value of nutrient cycling and bio- remediation through microbial processes are to the order of 17.5 - 27.5 kg/ha of added bio-fertilizer. The research is expected to contribute to the understanding of ecosystems services from agriculture and convince for the development of an institutional mechanism to channelize investment to improve these services and quality of life.

Sub-Theme T7: Natural Resource use in Agriculture

Session T7.1: Data Analytics in Soil, Water Resources Management and Precision Agriculture

T7.1.1: Water productivity for irrigated sunflower under different irrigation intervals on gezira clay soil, Sudan (Abstract Id: A5-7-011)

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Gezira scheme (GS) is the largest agricultural irrigated scheme in the country, which lies between the Blue Nile and White Nile Rivers. Water productivity in Gezira scheme is low and faced many problems during the last two decades. Water shortage during the growing season, especially, during the sensitive crop stages is the main one of these problems in the scheme. Water productivity can be enhanced by many ways of water conserving techniques such as partial irrigation, drip irrigation and deficit irrigation. Generally, these techniques appear to increase WP but with a significant yield reduction. In this study deficit irrigation technique was used to improve water productivity for Sunflower under Gezira condition. The results revealed that in the first season, higher WP of 0.26 and 0.25 kg/m3 were obtained from irrigation every 10 days before flowering and during seed filling stages. WP was low when Sunflower received irrigation at 20 days intervals during the two respective stages. In the second and third season irrigation treatments of F3 and S3 were obtained lower WP of 0.26 and 0.27 kg/m3 respectively. Also the results indicated that the EWP is generally very low. Highest economic water productivity of 0.30 US$/m3 was obtained from weekly and 10 days irrigation in the first season compared to the other two

seasons. While the lowest values of EWP of 0.22 and 0.19 US$/m3 were obtained from prolonged irrigation intervals of 20 days after flowering in the first and second season respectively. This study concluded that decreasing water use through deficit irrigation also decreases the EWP.

T7.1.2: Drought and surface water monitoring: Remote sensing technologies for decision making
(Abstract Id: A7-9-006)

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A drought is a reflectance of below-average precipitation in a given region and results in to reduced crop growth and lesser agricultural production. Precipitation depends upon several meteorological factors of which an essential one is surface water. Surface water bodies are dynamic in nature as they shrink, expand or modify their appearance or change course of flow with time, owing to different natural and anthropogenic factors. Reliable drought monitoring and early warning are too important interventions for drought preparedness planning and mitigation and reduce adverse effects on agriculture. Agricultural droughts can then turn into hydrological droughts, which refer to deficiencies in surface and subsurface water supplies. The different drought definitions imply that several parameters are used to monitor drought, which can be observed from remote sensing technologies. Satellite-based remote sensing has been widely used over the past several years for monitoring drought and surface water levels at village to global-scale. Keeping in view all the dimensions of the agricultural drought, a research study was designed to develop various indices to monitor drought and decision support system to help early warning systems. The main objective of the study was to find the status of vegetation at village level and it plays an important role to assist policy makers as a decision support feature. Satellite derived data sets have been used to study the time series trend of NDVI (Normalized Difference Vegetation Index) , NDWI (Normalized Difference Water Index) and NDDI (Normalized Difference Drought Index) for Tallasingaram village, Nalgonda district, Telangana state. The study uses Landsat 8 with 30 m resolution 8 days interval images from 2013-2018. The results shows that, a temporal curve that summarizes the various stages that green vegetation undergoes during a complete growing season. This information helps the planners and decision makers to evaluate performance of vegetation growth at village level, in turn assess the crop insurance claims by the farmers. Enhanced Vegetation Index (EVI) was also developed as an alternative vegetation index to address some of the limitations of the NDVI. These remote sensing technologies also provides an enormous amount of data at different spatial, spectral, and temporal resolutions for detecting and extracting surface water using efficient water indexes such as Normalized Difference Water Index (NDWI) and the modified Normalized Difference Water Index (mNDWI). Characterization of surface water dynamics is necessary for studying ecological, hydrological processes and agricultural planning. In this study uses 30m resolution Landsat 5, 7 and 8 top-of- atmosphere (TOA) reflectance 16 days collection were used to study the time series trend of surface water from 2013 to 2018 for Telangana state. The surface water estimation results were compared with post monsoon rainfall and ground water levels. The results found that, where ever rainfall is more surface water is more accordingly ground water levels are increased.

T7.1.3: NRM data needs for real time decision making
(Abstract Id: A7-9-009)

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The agricultural production system is an integrated output of several inputs, namely, soil, water, nutrients, plant and climate variables and their interaction. The variables involved in the process vary in their magnitude, scale and inherent properties both spatially and temporally. Their measurement and estimation techniques are equally variable, some easily determined and some complex requiring skilled and trained manpower. With advancement in technologies, the data needs are also undergoing a sea change. When data over large periods is analysed, the output is also influenced by the technological interventions in terms of new varieties, nutrient inputs, plant protection measures to name some. To isolate the impact of weather (climate) changes, technological inputs, gradual degradation of the natural resources (soil & water) in particular, necessitates refining and developing statistical techniques to identify the role of the component variables with a satisfactory level of confidence. Soil health card is one example in which a large numbers of geo-referenced parameters are being measured for each holding and repeated every three years. How to make this huge exercise cost effective with a robust quality check mechanism for the best and optimal utilization of the generated data, is urgently needed. It is not only the statistical techniques but also the recording of data regularly as well as the methodology for deducing parameters that are not measurable or estimated routinely. Data recording would be even more vital as agriculture in India becomes more technology oriented. For example, precision farming requires information from several sources like remote sensing, sensors, drones and yield data etc., all geo- referenced on a GIS platform. It may require linking with land ownership records and land use classification. It will involve a seamless merging of multi-source data and interpolation and optimization techniques, probit analysis, response surface methodology. For real-time decision making, development of Decision Support Systems (DSS) consisting of Decision Trees, Neural Networks, Artificial Intelligence, IoT, Big data Analytics, Weather forecasting and so on, will be required. An attempt has been made in this paper to identify and propose an action plan on the role that official statistics can play in this process.

T7.1.4: Biased subjective beliefs and nitrogen management in US agriculture (Abstract Id: A6-8-031)

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Nitrogen use on farm field affects agricultural productivity, soil quality, water quality, in particular, eutrophication of surrounding rivers and lakes, and risk exposure. The nitrogen management decisions of farmers hinge on their subjective beliefs about the nitrogen-yield relationship, coupled with perceptions of uncertainty and risk preference. With few exceptions, agronomists and agricultural economists have studied fertilizer application rates with an implicit assumption that farmers hold rational beliefs about the role of nutrients in crop production. Most studies use data on post- growing season yield to infer nitrogen decisions, under the rational expectations assumption. However, rational expectations is a convenient theoretical construct that generally finds little support among real world decision making. This study measures the extent to which real world nutrient management decisions conform to the rational expectations construct in the US agricultural heartland. We measure farmers' subjective beliefs about farm management practices through a web-based primary survey in Iowa and Southern Minnesota, US farmers. Farmers report nutrient application schedules for corn crops for the 2019-growing season. We elicit yield expectations, perceived weather outcomes and weather effects on yield, and importantly, the role of nitrogen in corn yield. We elicit subjective yield distributions through an assessment of the "chances out of 100" that random yields fall within determined thresholds. Expected yields corresponding to pre-formed nitrogen and weather counter factual are also elicited. Finally, we link insurance uptake and weather beliefs to cropping decisions. We are able to characterize the subjective yield densities of

individual farmers by fitting a beta distribution to the measured beliefs. The beta density can flexibly model the positive or the negative yield skewness, which resonates with downside yield risk. The first three moments of the yield density – mean, variance and skewness are estimated and regressed against farm and farmer characteristics to identify systematic bias in subjective beliefs. Subjective yield distributions are tested against an objective benchmark obtained from survey data that is maintained by Iowa State University extension services. We contrast subjective marginal and average productivity of nitrogen against the objective benchmark to assess bias. We find that Iowa farmers generally overestimate the marginal product of nitrogen. The bias varies across farmer and farm characteristics. The bias seems to be lower for farmers using higher levels of nitrogen, and even lower if the nitrogen has been applied during fall or after planting instead of before planting. Among the field types, the bias is significantly lower for under-performing fields. Recent advances in behavioral economics and psychology have revealed that average rather than marginal rates are more intuitive and easily implemented in decision-making under uncertainty, a term coined 'schmeduling'. We find evidence of similar patterns of bias among Iowa farmers. The implications for designing effective polices to improve nitrogen yield efficiency and water quality are profound.

Session T7.2: Compilation of forestry accounts in African countries - Implementation of the System of Environmental-Economic Accounting-Agriculture Forestry, and Fishery (SEEA-AFF)

T7.2.1: Application of environmental extended-supply use tables (EE-SUT) on forestry in Senegal
(Abstract Id: A2-2-051)

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Environmental accounting is a system for listing, organizing, managing and providing integrated environmental and economic data and information through physical or monetary indicators. By bringing the economy and the environment closer together, it provides more information, and promotes transparency and accountability for political action with respect to the environment. For example, developing environmental accounts under the Economic and Environmental Accounting System (SEEA) enhances the capacity of countries to plan, monitor and report on progress and achievements of the Sustainable Development Goals (SDGs) with international statistical standards. Senegal has therefore embarked on a process of preparing physical accounts of the environment, particularly those of forests and timber resources, since the country's environmental policy focuses on the rational management of natural resources, in a perspective of sustainable development. The National Agency for Statistics and Demography (ANSD) is leading this activity in close collaboration with the Ministry of Environment and Sustainable Development (MEDD) with the support of the Economic Commission for Africa (UNECA) and the United Nations Food and Agriculture Organization (FAO). The main purpose of the forest accounts is to bring together in an accounting framework the environmental (physical and ecological) and economic data needed to assess the "sustainable" nature of the management of the forest resource, a renewable natural resource, at the level of the forest. 'a country or a set of countries. They integrate: (i) area accounts that allow the monitoring of available forest lands and apprehend their evolution; (ii) volume accounts that allow the monitoring of timber resources, usable (timber harvesting) and set aside (wood stocks in forests) and the analysis of the ecological viability of the exploitation that is made of this resource and (iii) economic accounts, which provide information on the profitability of the forest-timber-

wood processing industries. In the application of the Environmental Extended-Supply Use Tables (EE-SUT) on Forestry in Senegal, the focus is on volume accounts. During the biennium, it appeared necessary to carry out two SUTs, one for wood forest products and the other for non-timber forest products. Thus, for the SUT of wood forest products, the unit is m3 and for non-wood forest products, the unit is the tone. This work complements the study on the assessment of the contribution of the environment to GDP, which showed a contribution of 1.9%. Notwithstanding this seemingly low contribution to GDP, the environment plays an important role in meeting people's needs by improving their income and providing them with non-market consumer goods. Indeed, Senegal's forest ecosystems contain a wide and diversified range of supply services, regulatory services, recreational services, cultural and educational services. The main constraint in the application of the Environmental Extended-Supply Use Tables (EE-SUT) on forestry in Senegal relates, on the one hand, to statistical gaps, and, on the other hand, to the fragmented nature of the data. existing. It is therefore necessary to improve the collection system and ensure the regular completion of forest inventories at the national level.

T7.2.2: Experimental forest accounts in Cameroon: Physical supply and uses table for timber resources (Abstract Id: A2-2-048)

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Forest is an important resource for Cameroon. Forest lands make up 39.3% of the country's total land area. Forestry, logging and wood industry activities account for 4.8% of country's GDP. However, the contribution of forest sector to the economy remains poorly known, due to lack of integrated statistical data on forests. Moreover, in a context of need for sustainable development, policymakers need integrated information to assess the sustainable management of forest resources. The System of Environmental-Economic Accounting Central Framework (SEEA-CF) is an international statistical standard that aims at organizing relevant statistical information within an integrated framework, coherent with the System of National Accounts (SNA 2008), to facilitate analysis of key processes and their evaluation. FAO and the UN Statistical Division (UNSD) have developed a SEEA for Agriculture, Forestry and Fisheries (SEEA-AFF) manual for application of SEEA-CF in these domains. Cameroon has been selected as a pilot country to test the forest accounts, in application the SEEA-AFF manual, as part of the United Nations Economic Commission for Africa (UNECA) Capacity-Building Programme on the Compilation and Application of Environmentally Extended Supply and Uses Tables (EE- SUTs) in Africa, which seeks to disseminate the implementation of SEEA-CF recommendations in African countries. This paper aims to showcase the experience of Cameroon in the compilation of physical flow accounts of wood forest products, as a first step in the compilation of forest accounts, according to the SEEA-CF.

T7.2.3: Forestry and exchanges with other industries in the national accounts of Morocco (Abstract Id: A2-2-050)

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Forest development is part of Morocco's development plan. The country has started in recent years' procedures for the compilation of environmental accounts following the System of Environmental-Economic Accounting Central Framework (SEEA-CF) that is an international statistical standard with the System of National Accounts (SNA 2008). In Morocco, the compilation is carried out locally by the

Department of Water and Forests, the Department of Agriculture and the High Commission plan. The presentation will aim to complete the first in terms of describing the relationship between industries (forest –others) and their effect in adjusting and filling the data gap based on product balance. In this presentation, we will show the lessons learned in the compilation of the Environmental Extended-Supply Use Tables (EE-SUT) on Forestry account of the forest account, then, we show the exchanges with other industries in the national accounts of Morocco. We show how and where the forest is interacting with other industries in the country in the national accounting system.

T7.2.4: Forestry in the national accounts of Morocco
(Abstract Id: A2-2-049)

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The presentation will focus on the description of the Moroccan experience in terms of the compilation of forestry accounts (forestry and logging activity accounts and balance of resources and uses of forest products) for the base year 2007 (Current national accounts reference year). It will also present research and outstanding work on the forest sector in the new base year 2014 (compilation in progress). The compilation is based on the System of Environmental-Economic Accounting Central Framework (SEEA-CF) that is an international statistical standard with the System of National Accounts (SNA 2008). With the support of the United Nations Economic Commission for Africa and the Food and Agriculture Organization, Morocco has started to compile the Environmental Extended-Supply Use Tables (EE-SUT) on Forestry account. For this, we use the manual for application of System of Environmental-Economic Accounting Central Framework (SEEA-CF) developed by FAO and United Nations Statistical Division (UNSD). In this presentation, we present the steps for compilation of the Environmental Extended-Supply Use Tables (EE-SUT) on Forestry account. We show the sources of data used for the compilation and the type of estimation.

T7.2.5: Lessons learned from the application of environmental extended-supply use tables (EE-SUT) on forestry in Senegal
(Abstract Id: A2-2-052)

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The impact of human activity on the environment has become one of the most important issues facing governments. The effect of each country's economic activity on the local and global environment is of growing concern. Maintaining economic growth and quality of life depends on the benefits of the environment. It is important to question how natural heritage is used. For example, the following questions are asked: are resources extracted too quickly without any prospect of replacement? Does economic activity generate a level of pollution that exceeds the absorptive capacity of the environment or harms the health and well-being of humanity? The use of forest account data can: contribute significantly to poverty reduction through the conservation and sustainable management of forest potential through, inter alia, the coherent implementation of the decentralization and cooperation policy in the framework of local, international and international conventions; sub regional partnership; conserve forest potential and ecological balances; to guarantee, in a sustainable manner, the satisfaction of people's needs in wood and non-wood forest products. monitor the dynamics of vegetation and biodiversity; develop a management

plan; contribute to food security by improving the nutritional status of populations. The implementation of the project in Senegal required the signature of a partnership agreement between the National Agency for Statistics and Demography and the Ministry of Environment and Sustainable Development which led to the establishment of a technical committee. The work was done through a participatory process through the holding of technical committee meetings and workshops with the support of experts from ECA and FAO. The main lesson of this process is that its success depends on a combination of efforts with the establishment of multi-disciplinary working groups: national accountants, economists, foresters, etc.

Sub-Theme T8: Climate Change and Environmental Issues

Session T8.1: Disaster Assessment

T8.1.1: Socio-economic analysis of floods in Kerala-2018 (Abstract Id: A8-10-016)

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Kerala (India) experienced the worst flooding in the century, declared a level 3 calamity where one sixth of the population was directly affected. The present study was conducted (i) to study the extent and pattern of damage caused by flood in the individual households and (ii) to examine the factors affecting the degree of resilience among the individuals. Resilience is now commonly understood as the ability of a system (individual, household, community or society) to withstand, recover or even become stronger from exposure to critical incidents or shocks. Primary data were collected from two worst affected districts Alleppey (Kuttanad) and Idukki through interview schedule among a total of 98 respondents under different categories of occupation viz. farming, farming and non farming activities, farming and service, non farming and service. Multinomial logit regression model was used to assess the factors affecting post flood resilience among individual households. Low (base outcome), medium and high resilience score were assigned considering social factor, economic factor (income generation and financial security) and repair and recovery. Factors considered were education (year of schooling), annual income, damage cost, income sources and social support. Average damage cost was found to be 13.36 lakhs in Idukki which was affected by flooding as well as landslides and 2.82 lakhs in Kuttanad. Relative loss which is the average damage cost as percentage of annual average income was found to be 364 for Idukki and 102.24 for Kuttanad. Agricultural damage accounted for 65 % of total damage cost in Idukki whereas damage to house and household inventories accounted for 25% and 5 % respectively. Income loss and business loss were found to be less than 5% and only 1.28 % of total damage cost was recovered. In case of Kuttanad, agricultural damage accounted for 31.86 % whereas damage to house and household inventories accounted for 15.75 % and 13.50 % respectively. Income loss and business loss were found to be less than 10% and only 30.59 % of total damage cost was recovered. Income generation post flood was found to be affected by the type of occupation. Forty four per cent of the respondents were solely dependent on farming in Idukki where 48% of the respondents could not generate any income post flood. In case of Kuttanad, only 20 % of respondents solely depend on farming and 26% were unable to generate any income post disaster. Thirty six per cent of the respondents in Idukki and 46 % in Kuttanad generated income less than pre flood situation. Estimates of multinomial logit regression showed education (0.29*) and damage cost (-0.09**) were the significant factors affecting medium resilience where as in case of

higher resilience annual income (0.09*) was also found to be significant in addition to education (0.53***) and damage cost (-0.21***). LR statistic was found to be significant (40.49) with p-value 0.0001. The study also implied inadequacy in disaster warning, insurance penetration and ensuring financial aid considering the extent of damage and the economic status.

T8.1.2: FAO's methodology for damage and loss assessment in agriculture (Abstract Id: A8-10-013)

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One of the key aspects of reducing economic loss from disasters consists in a comprehensive analysis of the impacts generated and their associated cost. Detailed assessments of overall loss and damage are regularly carried out by governments and multilateral organizations following large-scale disasters using different methodologies. However, when applied to agriculture, these assessments often fail to capture the specificities of the sector and result in an imprecise or under-estimated evaluation of disaster impact. This hampers adequate agricultural disaster risk reduction (DRR) policy and planning, and leads to under-investment in resilient agriculture. The FAO has developed an agriculture-specific methodology, which provides a framework for identifying, analyzing and evaluating the impact (damage and loss) of disasters on the sector. Seeking to standardize disaster impact assessment in agriculture, FAO's Damage and Loss Methodology corresponds to universal norms, commitments and collective action at the global level, while remaining flexible enough to be applied in various country/regional contexts. The tool serves both national policy and planning needs as well as the post-2015 international resilience agendas, including the Sendai Framework and Sustainable development goals (SDG). This paper presents the FAO Damage and Loss Assessment Methodology as a framework for identifying, analyzing and evaluating the impact of disasters on agriculture, including crops, livestock, aquaculture, fisheries and forestry. Its potential is explored as a strategic tool for assembling and interpreting new or existing information to inform risk-related policy decision-making and planning. Furthermore, the FAO methodology is presented in the larger context of the current global resilience agendas, such as the Sendai Framework, while its linkages and complementarities with similar approaches are explored (PDNA, ECLAC's DaLA, etc.). In addition, the flexibility of the methodology in terms of estimation and data needs, as well as its ease of use and wide range of applicability are emphasised. This paper presents the first structured and systematic documentation of the methodological rationale, forged by a detailed elaboration of the methodological framework.

T8.1.3: Using farm-based agricultural surveys to estimate damage and loss from disasters in agriculture – Evidence from Nepal (Abstract Id: A8-10-014)

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In recent years, the growing recognition of the significant impact of disasters on agriculture has faced countries with the urgent need to collect and compile relevant statistics on production loss. Agriculture is particularly vulnerable to extreme weather and disasters, such as drought, floods, storms, earthquakes, which can be detrimental to crop growth, livestock health, fisheries and aquaculture production and can seriously undermine forest systems. Detailed damage and loss information is crucial in order to establish a

solid evidence base for policy making and strengthening agricultural resilience. Moreover, disaster impact in agriculture is a critical part of the SDG agenda and the Sendai Framework. SDG Indicator 1.5.2 and its corresponding Sendai Target C-2 specifically address the need to reduce global economic losses from disasters in agriculture. The methodology behind these indicators, developed by FAO, calls for thoroughly documenting the damage and loss in each domain of the agricultural production process. Yet, the sector is currently starved for reliable, detailed and consistent statistics on disaster impact. In order to bridge this data gap, it is crucial to develop adequate disaster impact information systems for agriculture – including streamlined data collection structures, strengthened capacities and targeted information sharing. National Statistical Offices have a vital role to play in this endeavor. An effective system of national agricultural surveys should incorporate regular data collection on damage and loss from disasters. This paper presents a standardized module for damage and loss data collection, which can be easily incorporated into annual agricultural surveys and is meant to support the establishment of institutionalized Damage and Loss Information Systems at country level. The proposed data collection module is focused on providing a tool for statisticians embarking on collecting high-quality data on disaster loss and damage in agriculture in the context of national statistical systems and through the implementation of farm- or household-based agricultural surveys. The module is directly structured to provide the necessary information for Sendai and SDG reporting and consists of questions covering crop production losses, livestock deaths attributed to disasters, input and output losses, destroyed machinery and assets as well as fishery, aquaculture and forestry losses. Furthermore, the paper presents findings from recent trials of the damage and loss module during the implementation of AGRISurvey in Nepal. Nepal is among the most disaster-prone countries in the world and is exposed to a variety of threats. Over 80% of the population is at risk from hazards, such as floods, landslides, windstorms, fires and earthquakes. In the most disaster- and earthquake-struck parts of the country, over 75% of the population is involved in agriculture for either subsistence (64%) or commercial farming. Agriculture accounts for 34% of annual GDP, with farming systems using a mix of crop and livestock production (Government of Nepal, 2015). Understanding the extent of disaster impact on agriculture is therefore key for national resilience policy, planning and action. Incorporating a damage and loss component within the AGRIS-based agricultural survey in Nepal highlights the country's progress towards disaster statistics.

T8.1.4: Climate change vulnerability of rural households in flood-prone areas of Himalayan foothills, West Bengal, India (Abstract Id: A8-10-017)

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The Himalayan foothill of West Bengal is the part of great eastern Himalaya; which is by locational virtue a recognized flood-prone area; where 80- 85% seasonal rainfall concentrates in four summer months. The area is well known for the frequent heavy rain storm and climate-induced catastrophic event. Moreover, the flash flood event is very common due to the unprecedented rain in Bhutan Himalaya. Therefore, climate-induced disaster like flood has been the prime reasons for rural vulnerabilities. However, there is potential knowledge gap of climate change vulnerability of households in a changing climate in this region has been found. Therefore, the primary aim of the present study is to find out whether there is any difference between level of vulnerability between the agricultural dependent village and forest resource-dependent village in the same flood-prone area? In addition, how the agricultural dependent village different from forest resource-dependent village in terms of climate vulnerability and vice versa? The climate change vulnerability index has been applied and total of 100 households have survey based on relevant indicator covering seven dimensions of vulnerability. The height exposure score has found highest in Raja Bhatkhawa (0.41) followed by Nathuar Char (0.30) and Bhelakoba (0.27); There are no

significant different found in terms of climatic exposure except Mendabari. Further, in Mendabari and Raja Bhatkhawa lower adaptive capacity has been observed. Although, it has observed that households resilience factor like education, workforce opportunities, health, and institutional accessibility are highly uneven which has been creating hinders to adaptive capacity. The villages where overall vulnerability to climate change has found high where the adaptive capacity is low, simultaneously, the sensitivity has found high. It has found that the location of the villages plays important roles on vulnerability because the relatively the forest villages are more vulnerable than the agricultural villages. However, riverside location of Nathuar Char has made this highly vulnerable. The people of Nathuar Char have been living with flood and they are trying to adapting with climate induced flood. It has also observed that vulnerability is context depended (land resource, accessibility of basic infrastructure, water and sanitation facility, and awareness) and varies to household to households.

T8.1.5: Disaster statistics in Asia & the Pacific – historical records of disaster impact on agriculture
(Abstract Id: A8-10-015)

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Over the past decade, natural disasters such as drought and flood have been increasing due to climate change. In addition, diseases and pests related to agriculture and livestock including African Swine Fever are likely to pose a serious threat to food security and sustainable living in rural areas, as well as the survival of subsistence farmers, for whom agriculture a major livelihood. In order to cope with the risks of disasters, climate change related events, environmental degradation and globalized economic development, UN has set disaster related associated targets of SDGs. UNISDR is working to prevent new and reduce existing disaster risks through the 'Sendai Framework for Disaster Risk Reduction (SFDRR) 2015- 2030'. FAO also has set "Increase the Resilience of Livelihood from Disasters" as one of key strategic objectives and has been pursuing diverse policies. For the same reason, in many countries, various efforts are being made to prevent disasters and increase response to disasters. Disaster should be considered as a problem in areas including adjacent countries, rather than occurring independently in each country. From this perspective, the role of individual countries in disaster is also important, but FAO strategic regional response (FAO-RAP) across the Asia-Pacific region seems of crucial priority. In order to establish policies in each country or local government as well as FAO, the production, management and appropriate use of relevant statistics are very important. For this reason, various statistics are being produced and managed in the agricultural sector, and disaster statistics are expected to become increasingly important. The purpose of this paper is to examine current frameworks and programs related to disaster statistics and to see whether any gap is existing between the needs of FAO-RAP and them. If such gap is found, it will also be considered which action would be needed to fill it. Also, it may include suggestions on what is needed to manage future disaster statistics in FAO-RAP. The paper will focus on the following issues: The current state of technology for disaster statistics; Literature review of prior studies on disaster statistics in agriculture field; Examining current framework and program related to Disaster Statistics under discussions and consultations with ECTAD team in RAP and Statistical Division (ESS) of H/Q; Overview of Status of Disaster Statistics Policy Implementation by Country in Asia-Pacific Region; Review necessary statistics and techniques for disaster-related policy; Cooperation with the Asia and Pacific Commission in Agriculture Statistics (APCAS)

Session T8.2: Climate Change and Environmental Issues

T8.2.1: Monitoring the agri-environment (Abstract Id: A8-10-030)

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Sustainable exploitation and sustainable food security and safety are currently priorities of special relevance for the future of the planet. They are currently threatened in many areas of the planet by the competition for land, water and other natural resources as well as climate changes (causing biodiversity losses, plant and animal diseases, etc.). At the same time, the food production should be increased by 60% to guarantee food to the global population who is projected to reach over 9 billion by 2050. Agri-environmental trade-offs are issues critical for policy makers charged with managing both food supply and the sustainable use of the land. Reliable data are crucial for developing effective policies and for evaluating their impact. However, often the reliability of agri-environmental statistics is low. The paper addresses problems related to monitoring the agri- environment and discusses the use of geospatial information and ground data for accurate, timely and cost-effective estimation of main typologies of agri-environmental parameters and indicators.

T8.2.2: Role of climate distribution on World, US, & Indian crop yields (Abstract Id: A8-10-011)

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The World, U.S. and Indian crop yields have been evolving and adapting to ongoing changes as reflected by statistics on production, trade and productivity growth rate. The economics and econometrics of crop yield-climate are well established (Schimmelpfenning, 1996; Darwin, 1999; Mendelsohn and Neuman, 1999; Pacala and Socolow, 2004; Semenov et al, 1998; Lobell and Burke, 2010; Butler and Huybers, 2013; Carter, 2013; Challinor et al, 2014; Deschenes and Greenstone, 2007; Dell, Jones and Olken, 2014) using statistical, simulation and programming methods. The theoretical basis of these studies includes partial and general equilibrium analyses; primal production functions and Ricardian framework. The primary emphasis of these research was to show the physical crop yield-climate relationships and estimate cost of the climate changes. Within this research, researchers have shown the relationship between crop yield-climate with or without accounting for potential linear or nonlinear technology trends. In evaluating crop yield-climate relationship, including separable trends and climate overcomes potential interaction terms and collinearity. However, extending to include the four moments [mean, variance, skewness, and kurtosis] of climate and associated interaction terms could lead to potential collinearity issues in the estimation. To overcome collinearity issues, a two-step approach is proposed to evaluate the crop yield-climate relationships. In the first step, detrend crop yields are estimated accounting for potential linear or nonlinear trends in crop yields. In the second step, the detrends crop yields are used to evaluate the importance of four moments of climate variables. The detrended crop yields are used to estimate the efficiency of four moments of climate affecting maize, soybeans, and rice yield's using spatially referenced or georeferenced countries in the world, counties in U.S. and districts in India on crop yields. This will be compared to nonspatial regression models that does not account spatial interaction and heterogeneity using maximum likelihood techniques. Specifically, the statistical relevance of minimum and maximum temperature and precipitation will be evaluated using linear model, linear model with

spatial lag of exogenous climate variables, spatial autoregressive, spatial error, spatial moving average and, spatial autoregressive moving average models. The second objective is to evaluate the importance of a) intra-annual first and second moment of temperature and precipitation, and b) inter-annual short- and long-run second moment of temperature and precipitation directly on crop yields. Intra-annual variations capture changes in temperature and precipitation across months (from January to December) within a year. In contrast, inter-annual represents changes in temperature and precipitation through time to capture variations between years. How should the intra- and inter-annual variations in temperature and precipitation be defined? Should the intra- and inter-annual variations be reflected by the first (mean) and second (variance) moments of temperature and precipitation? To capture the distribution of temperature and precipitation in the analysis, the first and second moments will be used. The reason for sticking to just the first and second moment is because of the use of intra- and inter-annual variations.

T8.2.3: Water security and livelihoods in the highveld areas of Zimbabwe under climate change; Evidence from Chirimanyimo (Abstract Id: A8-10-006)

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Water is arguably the most important substance on earth with both plants and animals requiring it for survival. However, Climate change is having significant impacts on development, poverty alleviation, and the achievement of the Sustainable Development Goals. With natural regions in Zimbabwe gradually changing and shifting, serious concerns are raised about the current water resources planning and management in Zimbabwe in the high rainfall areas of Eastern Highlands of Zimbabwe (Nyanga-Chirimanyimo). There are great concerns that these previously well water resourced areas are gradually being turned into deserts with severe repercussions on the whole water catchment area. The study is framed within the social-ecology paradigm and set out to quantitatively investigate the explanatory causes of reduced surface and ground water discharge in the area. By deploying a mixed method approach in a case study the researchers analyze the causes and factors associated with surface water depletion using both quantitative and qualitative data. The study first uses satellite imagery (Normalized Difference Vegetation Index) to explain land use patterns over the last four decades and establish the impact of anthropogenic activities on surface water discharge as explained by the water-foot print of the community. With the help of Principle Component Analysis the researchers explore the components related to water insecurity and water poverty under climate change to help influence local and policy level decisions. The research also seeks to establish the relevance of local and national level institutions in the management of water resources and climate change mitigation.

T8.2.4: Comparative Analysis of Institutionally Promoted and Local Climate Change Adaptation Strategies by Small-Scale Farmers in Ghana (Abstract Id: A8-10-005)

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Climate change poses a huge challenge that threatens sustainable development globally. In Africa, its risks and impacts are of significant concern because of their linkage to food security, poverty alleviation

and sustainable development. Climate change adaptation approaches which are either promoted by well-established institutions or locally initiated initiatives have become the driving force for the mitigation of the effects on small-scale farmers. This study assessed institutionally promoted climate change adaptation approaches and local level climate change adaptation approaches as well as how the outcomes of the approaches differ among the two categories of small-scale farmers in the Garu-Tempane district of Ghana. The study adopted mixed methods, using data from small-scale farmers. The analytical approaches included thematic analysis, ordinary least squared (OLS) logistic regression and ratio models. Seven types of climate change adaptation approaches were common in the two set of communities, namely, planting shorter gestation crop varieties, planting late, dry season irrigation, river bank farming, changing of crop varieties within two years, refilling and planting in anticipation of rainfall. The results revealed that, although there were no statistically significant differences between the perceptions of climate change among the two set of farmers, overall, the beneficiaries of the institutionally promoted approaches had more output per land area as compared to the locally adopted approaches. Again, yield prediction revealed that farmers in the institutionally promoted category and some farmer socio-economic factors, are more likely to have higher yield as compared to their counterparts in the local approaches category. The findings also revealed that climate change adaptation approaches that are foreign to local farmers were less adopted as the zai and the half- moon approaches were completely abandoned by farmers. The findings presuppose that, institutionally promoted climate change adaptation initiatives should not significantly vary from what is already being known by farmers. It also reveals that although the climate change adaptation approaches could be similar among beneficiary and non-beneficiary members, their outputs vary significantly.

T8.2.5: Global warming
(Abstract Id: A8-10-007)

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Climate change refers to significant, long-term changes in the global climate.The global climate is the connected system of sun, earth and oceans, wind, rain and snow, forests, deserts and savannas, and everything people do, too. The climate of a place, say New York, can be described as its rainfall, changing temperatures during the year and so on. A description of the global climate includes how, for example, the rising temperature of the Pacific feeds typhoons which blow harder, drop more rain and cause more damage, but also shifts global ocean currents that melt Antarctica ice which slowly makes sea level rise until New York will be under water.It is this systemic connectedness that makes global climate change so important and so complicated.is the slow increase in the average temperature of the earth's atmosphere because an increased amount of the energy (heat) striking the earth from the sun is being trapped in the atmosphere and not radiated out into space.The earth's atmosphere has always acted like a greenhouse to capture the sun's heat, ensuring that the earth has enjoyed temperatures that permitted the emergence of life forms as we know them, including humans.Without our atmospheric greenhouse the earth would be very cold. Global warming, however, is the equivalent of a greenhouse with high efficiency reflective glass installed the wrong way around.Ionically, the best evidence of this may come from a terrible cooling event that took place some 1,500 years ago. Two massive volcanic eruptions, one year after another placed so much black dust into the upper atmosphere that little sunlight could penetrate. Temperatures plummeted. Crops failed. People died of starvation and the Black Death started its march. As the dust slowly fell to earth, the sun was again able to warn the world and life returned to normal. Today, we have the opposite problem. Today, the problem is not that too little sun warmth is reaching the earth, but that too much is being trapped in our atmosphere.So much heat is being kept inside greenhouse earth that the temperature of the earth is going up faster than at any previous time in history. NASA provides an excellent course module on the science of global warming. The most compelling climate

change evidence scientists have of climate change is long term data relating atmospheric CO2 levels and global temperature, sea level, the expanse of ice, the fossil record and the distribution of species.This data, which goes back millions of years, shows a strong correlation between CO2 levels and temperature. Recent data shows a trend of increasing temperature and rising CO2 levels beginning in the early 19th century.Because all parts of the global climate are connected, scientists have been able to create models of how changes caused by heating should work their way through the entire system and appear in different areas, for example, sea level, intemperate weather, the movement of fish species in the ocean.

Sub-Theme T9: Capacity Building in Agricultural Statistics

Session T9.1: Country Capacity Measurement

T9.1.1: Assessing the capacity of national statistical systems to compile and use SDG indicators related to food and agriculture

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The increasingly recognized importance of available and reliable national statistics to support development and progress has contributed to the recognition of the need for independent national statistical organizations or agencies and enhancement of their employees' technical competence. As a custodian agency, the Food and Agriculture Organization of the United Nations (FAO) is responsible for contributing to the improvement of statistical capacity for the reporting and monitoring of the Sustainable Development Goal (SDG) indicators. The statistical capacity development activities can effectively and efficiently be planned and provided after a comprehensive assessment of the national statistical systems. Countries and international organizations have been conducting statistical capacity assessments with varying focus and objectives at national, regional and global level. Although there are assessments focusing on food and agriculture statistics, they do not necessarily take into account the SDG Framework and 2030 Agenda for Sustainable Development. On the other hand, recent assessments on the SDG indicators are either too generic or not exhaustive to obtain a fully comprehensive picture of the challenges attached to reporting and monitoring of the SDG indicators related to food and agriculture at adequate spatial coverage. This paper aims to provide an insight about countries' statistical capacity to report on the SDG indicators for which the FAO is the custodian agency, i.e. SDG indicators 2.1.1, 2.1.2, 2.3.1, 2.3.2, 2.4.1, 2.5.1, 2.5.2, 2.a.1, 2.c.1, 5.a.1, 5.a.2, 6.4.1, 6.4.2, 12.3.1, 14.4.1, 14.6.1, 14.7.1, 14.b.1, 15.1.1, 15.2.1, 15.4.2. The results are derived from a survey conducted by the FAO Office of the Chief Statistician (OCS) in over 190 countries in 2019. The survey is designed in various sections to collect information on the national coordination mechanisms for SDG reporting, data availability, existing data sources and the needs for technical assistance. The respondents are the National Coordinator for SDG Monitoring or the SDG focal points nominated by the President of the National Statistics Office in each country. This paper summarizes the overall data collection process, provides results for the needs assessment for all countries involved, lists lessons learned and suggests improvements for future assessments.

T9.1.2: Evaluating progress on capacity development for agricultural statistics in Africa (Abstract Id: A10-11-009)

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The Africa Development Bank has been providing support to its Regional Member Countries on various agricultural statistics domains, within its Statistical Capacity Building (SCB) Program. The key objectives of the Agricultural Statistics Program of the Bank are inter alia, to build the capacity of African countries to generate timely and reliable data needed to inform national agricultural and rural development policies in Africa, as well as the Bank's Strategy for Agricultural Transformation in Africa, SDGs, and Africa Agenda 2063. One of the constraints faced in formulating the SCB Program in Agricultural Statistics was lack of comprehensive and up-to-date information with required quality on countries' statistical capacity and needs, in order to: (i) establish baselines for setting targets and performance measurement, (ii) establish country profiles and effectively group and rank countries by level of capacity/development of their agricultural statistics systems, (iii) draw up technical assistance program for Africa as a whole and for each country, and (iv) establish a monitoring and evaluation system to assist in monitoring progress and guiding implementation of the Program. At that end, the Program provided for undertaking, every two years, Country Assessments (CAs) of National Agricultural Statistics Systems (NASS) to measure the capacity of countries to produce timely and reliable agricultural statistics. In fact, the CAs cover four dimensions of NASS capacity, namely: (i) the country's state of institutional infrastructure (Prerequisite dimension), resource capacities (Input dimension), statistical methods & practices (Throughput dimension), and availability of statistical information (Output dimension). The results of the CAs are a set of Agricultural Statistics Capacity Indicators (ASCIs) that reveal the progress African countries are making along the time in all these 4 dimensions. So far, three CA cycles have been undertaken for following reference years: 2013, to set the needed baseline information for the implementation of the SCB Program in agricultural statistics; 2015, to measure the progress being; and 2017, to measure the impact produced. The indicators produces from these CAs reveal which countries have shown signs of improvement in their capacity to produce relevant agricultural statistics, as well as those exhibiting some weaknesses. These findings are critical for illuminating areas of underperformance in some African countries, which can then be targeted for additional assistance. They also help to identify the high-performers so that their systems and procedures may serve as best practices to be emulated by those countries showing slower progress. Overall, the results of these CAs show that there has been a general improvement (of 9.4%) in agricultural statistical systems across Africa over the past few years as manifested by notably improved quality and quantity of agricultural data being currently generated by African countries. The paper makes a case for the usefulness of such robust ASCI system in measuring and monitoring the implementation progress of capacity building programs in agricultural statistics. It also presents (i) the design and standard methodology used across the continent, which enables aggregation and comparability between countries and over time, (ii) key results obtained, and (ii) experience, lessons learnt and best practices.

T9.1.3: Statistical performance index- Measuring the statistical capacity of nations (Abstract Id: A10-11-019)

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Improving the capacity of national statistical systems (NSSs) has long been a part of global development agenda. However, in-depth capacity assessments of NSSs is resource-intensive, time consuming and open

to subjectivity of assessors. Given the difficulties of synthesizing detailed assessments to determine progress on a global scale, there is an understandable desire to form a single composite index drawing from publicly available information. The Statistical Performance Index (SPI) in conjunction with Country Statistical Profiles provide such a measure that also help compare countries and to track performance over time. The SPI aims to provide an objective, justifiable/verifiable assessment of statistical performance of countries over time by using publicly available information from international agencies and country websites that were produced by NSSs. The SPI framework helps countries and development partners identify the strengths and weaknesses of NSSs and areas of potential improvements. It could also provide actionable guidance for NSSs in areas that may require further deeper assessment. Key characteristics and role of the SPI are: Uses only publicly accessible data; Transparent methodology; Easily replicable; Provides a long-time series to track progress in performance; Captures outcomes and supporting elements; Reflects some of the SDGs; Facilitates at-a-glance comparisons on a global scale The concept behind the SPI views the statistical capacity of an NSS in terms of its range of products, and the processes the NSS uses to generate and disseminate them. This approach identifies four dimensions for a measure of statistical performance: 1. Methodology, Standards and Classifications: provides information on the technology being used by NSS 2. Census and Surveys: describes the intermediate products of NSS 3. Availability of Key Indicators: focuses on key final products needed for policy 4. Dissemination Practices and Openness, which evaluates the extent to which products are publicly disseminated The SPI is designed to satisfy seven criteria: 1. Simple: easy to describe 2. Coherent: conform to a common-sense notion of what is measured 3. Motivated: fit the purpose for which it is developed 4. Rigorous: technically solid 5. Implementable: operationally viable 6. Replicable: easily replicable 7. Incentive Compatible: must respect country incentives The SPI also satisfies three axioms. The symmetry axiom requires that index value is unaffected when variable levels are switched.The dominance axiom requires that the index value rises whenever one variable rises from 0 to 1 and the rest of the variables do not fall in value. The subgroup decomposability axiom allows the index to be divided into salient sub-indices and linked back to the original index for policy analysis. They provide a theoretical framework that guides indicator selection and informs how indicators are aggregated into a summary measure. The SPI is flexible enough to allow for future revisions as global data landscape evolves. This SPI could be the first step before more resource-intensive country-specific assessments to inform multi-year improvement plans. The SPI may also be relevant to construction of other indexes in related areas, like tracking global SDGs or child development.

T9.1.4: India's capacity in agricultural statistics (Abstract Id: A10-11-005)

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India’s population size along with the increasing rate of population growth, has imminence pressure on the Agricultural system of the country. The necessity of food for all has resulted in increase in requirement of sufficient production of food grains to nourish a human body. Government of India has taken several measures to ensure adequate production of food grains and accordingly has invested a huge capital for precise scientific planning. The major Agricultural indicators projected by Government are estimated from Agriculture Census and Input Survey, Crop Cutting Experiments for the estimation of area, Production and Yield rate of Principal Crops, Land Use Statistics, Situation Assessment Survey of Agricultural Households by National Sample Survey, Livestock Census, Integrated Sample Survey. Also Production and Yield of Horticulture & Plantation Crops, Statistics on Imports and Exports of Livestock products and Agricultural produce and its products, Forecasting Agricultural output using Space and Agro-meteorology and Land based observations (FASAL) serve the same purpose. The recent development in Agricultural sector mainly targets the doubling of farmer’s income by 2022. It’s expected

to gain momentum in a short while, owing to enhanced investments for the improvement of Agricultural infrastructure such as irrigation facilities, warehousing and cold storage etc. The statistical capacity of Indian Agricultural system is measured by Agricultural Statistics, therefore complete planning and functioning of Indian Agricultural system is data driven. In India, Agricultural statistics are being generated both by Census and Surveys, which provide data on various dimensions of Agriculture. In this research work, an attempt has been made to assess the country's capacity of Agricultural Statistics and to identify and highlight the areas where focused attention is required to collect the statistics for a holistic plan for improvement of the overall Agricultural system of the country. Moreover, an attempt has been made to highlight the data gaps. These gaps if fulfilled, will enhance the robustness of existing indicators.

T9.1.5: Understanding and measuring data use in food and agricultural policies (Abstract Id: A10-11-018)

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The case for evidence-informed policy making has gained renewed impetus with the adoption of the data-driven Agenda 2030 with a measurement framework of 17 goals, 169 targets and 232 indicators. There is growing consensus that policy action must be informed by reliable and high-quality data. Parallely, the world is undergoing a data revolution, with a deluge of data from new sources and enabled by emerging digital technologies. This has given space for new actors and players to enter and shape the data ecosystem. Countries at different rates are witnessing and participating in this phenomenon which holds promise to alter the national and subnational policy processes. This presents a tremendous opportunity to gain richer, deeper, timelier insights to complement the data that are being collected through censuses and surveys. The data revolution does not guarantee data use in public policy design, implementation and monitoring and evaluation. Well-known barriers to data use exist, from data supply (relevance, quality, etc.) to data access and interoperability. The absorption capacityof potential users, from basic data literacy to more sophisticated analytical systems requirements, is also a challenge in many countries, in particular low and middle income countries. The presentation will show results of on-going work by PARIS21 on measuring data use in policy. It will present highlights of PARIS21 work in connecting the statistical and policy M&E communities through the Advanced Data Planning Tool (ADAPT), which is a platform to align the statistical production to key policy data needs. Finally, the presentation will introduce new developments to pilot new work meant at better understanding and measuring data use throughout the full policy cycle, beyond policy documents and M&E phases.

Session T9.2: Country Capacity Building

T9.2.1: Capacity building in agricultural statistics: Case of Georgia (Abstract Id: A10-11-016)

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Lack of timely, reliable and high-quality agricultural statistics affect scientific policy decision-making process, especially in developing and transition countries. Technical capacity building activities play crucial role in improving policy decision-making capacity in developing countries and provides access to the high-quality data. The objective of this manuscript is to discuss the role of United State Department of

Agriculture/ Foreign Agricultural Service (USDA FAS) and National Agricultural Statistics Service (NASS) long-term program activities that started in 2006 in Georgia. In this paper, we share the NASS and FAS experience and the common methods the agency is collaborating with the National Statistics Office of Georgia (GEOSTAT). The collaboration strengthens the quality of agricultural data by enhancing the capacity of GEOSTAT to collect, analyze, and disseminate agricultural statistics. Although the method has been implemented in Georgia, the procedure could easily be replicated in other developing countries. In addition, the NASS worked with the Georgian Ministry of Environment Protections and Agriculture (MEPA) to develop an effective agricultural information system to produce information for informed decision-making. The NASS in collaboration with the FAS work closely with GEOSTAT and MEPA to assist the development of data collection process in compliance with international standards. Moreover, the aforementioned agencies provide various training to GEOSTAT and MEPA employees, including an usage of administrative data on Small Area Estimation, computer assisted personal interviewing (CAPI) data collection, the modeling of yield data, analysis and imputation techniques for surveys and census purposes, frame maintenance, public relations, and quality management via a study tour to USDA. Importance of capacity building to the MEPA is of considerate importance for developing an effective agricultural information system and to include the creation of a policy unit within the capacity to conduct market outlook and various agricultural policy analysis. USDA will work with MOA, the National Statistics Office of Georgia (GEOSTAT), other organizations within the Georgian Government, non-governmental organizations, and foreign donor organization to identify data needs for an effective agricultural information system for Georgia. USDA's role was to provide methodological training, statistical consultation, help identify sources of data, and review the draft reports. While the Georgians will decide the ultimate function of the unit, USDA will advise MEPA staff as they define the organization and mission of the policy unit. The final objective of the program will be to leave a sustainable capacity within the ministry to continue the analysis without USDA's assistance. The objective of the paper will be to discuss the key procedural methodologies for quality and timely data collection systems applicable not only for Georgian market, but replicable on other developing nations as well.

T9.2.2: Technical assistance on Master Sampling Frame (MSF) in Africa (Abstract Id: A10-11-013)

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The distinctive feature of the Master Sampling Frame (MSF) is that it allows sampling for several different surveys or different parts of the same survey, which avoids the development of an ad hoc sampling frame for each survey. In the context of the Global Strategy to improve agricultural and rural statistics (GSARS), a MSF is a sampling frame or combination of sampling frames that covers the population of interest in its entirety and links the farm as an economic unit to the household as a social unit, and both to the land as an environmental unit. The MSF may consist of a list frame, an area frame or a multiple frames, combining list and area frames. The most common situations are MSF consisting of list frame or MSF consisting of list frame and area frame. As part of the Accelerated Technical Assistance Plan in Africa, the GSARS has signed a Letter of Agreement (LoA) with the Statistical and Economic Observatory of Sub-Saharan Africa (AFRISTAT) for the implementation of the technical assistance activities among which Master Sampling Frame (MSF) Technical assistance activities on MSF generally included capacity development (training workshop and learning by doing), technical and financial assistance for field test and drafting a methodologic document for MSF building in the country. In this paper, we will discuss the technical assistance in three countries (Cabo Verde, Madagascar, and Mali).

These three countries have in common a situation of scarcity of financial and human resources for agricultural statistics. Thus, MSF has appeared as an efficient way to reduce the cost of agricultural surveys. The experience of these countries provides an illustration of the steps to follow for MSF building according to the situation of the country: agricultural census completed (Cabo Verde), population census with an agricultural module in progress (Madagascar) or census of agriculture in preparation (Mali). From these three examples, we can highlight the difficulties encountered and the lessons learned.

T9.2.3: The role of statistical training institutions in capacity building in agricultural statistics: Evidence from Eastern Africa statistical training centre (Abstract Id: A10-11-015)

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One of the pillars of the Global Strategy to Improve Agricultural and Rural Statistics (GSARS) is the sustainability of agricultural statistics through governance and statistical capacity. The statistical capacity building takes into the quality of agricultural statistics as a function of their accuracy, relevance, timeliness, comparability, availability, and accessibility. In order to achieve this pillar the GSARS emphasis educating staff on statistical methodology for sampling, survey design, data compilation, and data analysis. As the deliverable the Eastern Africa Statistical Training Centre (EASTC) in collaboration with the Sokoine University of Agriculture established a master's of science degree in Agricultural Statistics which is geared towards producing competent and highly qualified professional agricultural statisticians who are endowed with both theoretical and practical perspectives and capable of meeting the demands of the present and future and world development agendas. Until its establishment, two batches are out and the immediate outcome in terms of methodological improvement is noticeable. Therefore this paper will address the role of statistical training institutions in capacity building in agricultural statistics with evidence from EASTC.

T9.2.4: A way of improving agricultural statistics in Cambodia (Abstract Id: A1-1-047)

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The National Institute of Statistics (NIS) of the Ministry of Planning (MOP) in Cambodia has a mandate for collecting, gathering, analyzing, publishing and disseminating the all data of censuses, inter-censal surveys and other surveys with high quality, timely, reliable statistics. NIS has conducted the first agriculture census in 2013 and has currently conducted the population census 2019 and is conducting the Cambodia Inter- Censal Agriculture Survey in July 2019 and will continue to implement the annual agricultural survey (AGRISurvey) in 2020-2022 with technical assistance from FAO using Tablets Survey Solution system (CAPI) for the field data collection. AGRISurvey will provide up-to-date information on economic, environmental and social dimensions of agricultural holdings for improving the National Statistical System of Cambodia, policy making and Cambodia Sustainable Development Goals (CSDGs) in the 2030 agenda, policy making for agriculture development. In this context, NIS has cooperated with Ministry of Agriculture, Forestry and Fisheries (MAFF) and FAO to conduct the Cambodia Inter-Censal Agriculture Survey 2019 (CIAS2019) and AGRISurvey 2020-2022 using tablets

CAPI, which is first using the new technology of the survey solution system for data collection in align with the global strategy to improve agricultural and rural statistics in order to improve the quality agricultural statistics to meet the new data requirements are emerging and relating to global warming, land and water use, and the increasing use of food and feed commodities to produce biofuels and relating to poverty and food security. The minimum set of core data on CIAS2019 is designed by using Tablets (CAPI) with 16,000 household samples of agricultural holdings within 25 provinces of the Cambodia. The field data collection is covered the production of crops, livestock, forestry and fisheries activities. However, there still have many challenges of the impact of agriculture on the environment and global warming, and sustain water and land resources. In addition, more challenges of governance and statistical capacity building for the field management of data collection and lack of institutional coordination and cooperation, lack of capacity to data analysis for policy making, difficulty of data users to access the existing data without explanation of technical notes or metadata. To improve better quality data and statistical system of Cambodia, NIS Cambodia has formulated the National Strategy for the Development of Statistics (NSDS) 2019-2023 that is aligned with the National Strategic Development Plan (NSDP) 2019-2023 and Cambodia SDGs framework. The NSDS Cambodia has introduced its strategic operations for delivering the quality statistical data to improve the National Statistical System of Cambodia and availability of information for people and government to ensure that "no one is left behind".

T9.2.5: Overcoming SDGs monitoring challenges in Myanmar: Preparatory progress and way forward
(Abstract Id: A11-12-008)

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This paper highlights the current situation of Myanmar's preparation for Sustainable Development Goals (SDGs) Implementation and monitoring against challenges which are arising from huge data demand on both national and sub-national level. Based on the monitoring experience of Millennium Development Goals (MDGs) era, the progress monitoring and evaluating the achievements remain questions on capacity of National Statistics Offices (NSOs) which are assumed to be main data supporters, in some cases as main players for monitoring and evaluation of MDGs. This paper aims to address several issues faced by NSOs of LDCs, Developing Countries and Small Island Countries, exactly the same cases in Myanmar. When MDGs was converted into SDGs with broader goals and targets, most of the NSOs are playing as the monitoring agencies for the country according to the lessons learnt from MDGs: importance of data as driving force for development plans, implementation and progress monitoring. However, the capacity and performance for NSOs especially from LDCs, Developing and Small Island Countries still remain the most challenging part for SDGs achievement due to inadequate investment in statistics, outdated ICT infrastructure, lack of skilled personnel and absent of HR plan in statistics. The worst thing among those would be remarked as the coordination failure in the National Statistical System. Myanmar, as like other LDCs countries, is facing same problems, in some cases, worse than others especially in government funded statistical development projects. After introducing several reforms, the newly democratic government pays attention to cut off government spending except for most urgent socio-economic and welfare needs of the country such as health, education, and rehabilitation of post disaster crises. Even though the government showed its appreciation of needs and importance of statistics for country development, the urgent issues for national priority sectors would come first for budget allocation. As better data can lead to better lives of the people of the country, the development of statistics sector is crucial for decision making, planning and monitoring process of the development projects. At the same time, the availability of SDGs indicators in Myanmar highly depends on international partners' assistance according to several assessments done by Central Statistical Organization (CSO) which is only

the one national statistical authority of the country. The organization is now under challenging for the long way of data mining and innovations in Myanmar due to high level of resource constraints. This paper will examine the possible solutions to existing challenges based on previous assessments done by CSO and partner agencies and in depth analysis on current capacity of CSO and performance of National Statistical System (NSS). It will also explore realistic recommendations on how to overcome massive data demand for SDGs Monitoring in Maynmar.

Session T9.3: Improving Statistics for Food Security, Sustainable Agriculture and Rural Development in Africa – Key results

T9.3.1: Impact of the provided agricultural statistics capacity building at national levels – Case agricultural cost of production in Madagascar (Abstract Id: A10-11-004)

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The agricultural sector plays a key role in the economy of Madagascar. Indeed, it contributes to about 26% of the Gross Domestic Product (GDP) and counts for nearly 78% of the active population. The development of the country, as a whole, depends therefore on how agricultural policies are planned and implemented. And, the available, reliable and up-to-date comprehensive agricultural statistics are fundamental for good governance and decision making within these policies. However, the situation is far from satisfactory in Madagascar. The country has a low capacity to produce agricultural statistics, as shown by the composite Agricultural Statistics Capacity Indicator (ASCI) which, until 2017, never reached the level of 40%. In fact, agricultural statistics in general, and those of Agricultural Cost of Production (AgCoP) in particular, were outdated and unreliable. It is for that reason that in 2017, Madagascar requested and obtained from the African Development Bank (AfDB), a technical assistance to improve its National Agricultural Statistical System (NASS) in general, and that of AgCoP in particular, to address challenges faced in that field. The needed statistical capacity building was provided in the framework of the implementation of the Action Plan of the Global Strategy for Improving Agricultural and Rural Statistics in Africa. Indeed, during the two last agricultural censuses which were carried out in 1984/1985 and 2004/2005, respectively, a module on estimating AgCoP statistics was included in the questionnaires: for paddy rice in census of 1984/1985, and for five commodities (paddy rice, maize, cassava, coffee and vanilla) in the census 2004/2005. Unfortunately, the country was lacking the capacity to go beyond that stage, and process and analyze the data collected on AgCoP. After the first exploratory mission to the country, the Technical Assistance on AgCoP statistics provided by AfDB achieved the following: (i) a Thematic Technical Working Group (TTWG) on AgCoP composed of representatives of different concerned agricultural sub-sectors was established and madeoperational; (ii) national experts were trained on the whole process chain of AgCoP statistics production; (iii) the required AgCoP methodology was applied; (iv) an AgCoP Simulation Tool was developed; and (v) AgCoP indicators for 2004 -2005 data (for the five above mentioned commodities) were calculated and published. As way forward, the AgCoP has been integrated into the next Agricultural Census (it is currently being prepared), and that will be the same for future agricultural surveys. The paper presents all these aspects, highlighting the impact of the received Statistical Capacity Building in boosting the development of the National Agricultural Statistical System (NASS) in Madagascar, while making available the needed AgCoP information to users.

T9.3.2: Impact of the provided agricultural statistics capacity building at national levels – case food balance sheets compilation in Tanzania (Abstract Id: A10-11-003)

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The agriculture sector plays a central and strategic role in development of many of African countries including Tanzania. Its role focuses on economic growth, increased income, enhanced food security at household level, eradication of poverty, as well as improve the living standard of its people. Agriculture activities are rural based, where the majority of the population makes their livelihood and participate in the whole process of production. In the process of raising people's living standards, through agriculture transformation which improves the efficiency of production and distribution of food and agricultural products in countries, timely and reliable statistical information is one of the most important prerequisites for formulation of sound development plans and policies (FAO, 2001). Therefore, lack of reliable and timely data from reliable data sources to measure the mentioned above indicators, is one of the challenges in most of the African countries. This paper will deal with how the availability of Food Balance Sheet (FBS) statistics in Tanzania, has improved more and better-quality agricultural data for evidence-based Planning, decision making and policy formulation to planners. Tanzania used to compile commodity balance sheets which was limited to some few selected major primary staple commodities. These commodity balance sheets failed to provide a right and complete picture of the food supply and use in the country because (i) it didn't include livestock, fish products, and (ii) didn't cover derived products, hence was not following the standard international method. An initiative was then taken to upgrade and enhance the existing system through the compilation of Supply and Utilization Accounts (SUA), including all the food commodities, both primary and processed. Moreover, the issue of inconsistencies in data from different sources has been addressed during the exercise of SUA/FBS compilation, which contributed to improve significantly their quality. Furthermore, the information on FBS has been an important input to national accounts, but also used to measure and analyze the overall food supply and demand over time, calculation of needed indicators at different levels, benchmarking, market situation analysis, as well as economic models for researchers, while informing the government and other stakeholders on food security situation in the country. Within the Statistical Capacity Building program of the African Development Bank, a robust SUA/FBS has been established in Tanzania, national experts from all concerned agricultural sectors (line ministries) capacitated to manage, maintain and sustain the system over the time, and for the first time in the history of the country, a comprehensive FBS report produced. The paper highlights the impact of the provided country capacity building in Food Balance Sheets compilation, with the aim of producing more and better agricultural statistics in Tanzania. It is important to note, the capacity for Tanzania to produce timely and reliable agricultural statistics has increased by 11 percent between 2013-2017, from 54.1% - 65.1% (AfDB, 2017). The paper also points out the usefulness of FBS statistics, how the international standard method was adapted to Tanzania context, and showcases key findings and lessons learnt from the process of FBS compilation.

T9.3.3: Measuring the capacity improvement of national agricultural statistics system to produce timely, reliable and sustainable agricultural statistics - Case of Senegal (Abstract Id: A10-11-008)

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The African Development Bank (AfDB) regularly assesses (once every two years) the National Agricultural Statistics Systems (NASS) of African countries, including Senegal, in order to measure progress in the implementation of its statistical capacity-building program in general, and that for the improvement of agricultural and rural statistics in Africa in particular. To date, the assessment of NASS has been carried out for the 2013, 2015 and 2017 reference years. These assessments collected information on four dimensions of NASSs' capacity (Institutional capacity, Availability of Resources, Statistical Methods and Practices, and Availability of Statistical Information), which led to objective measurements of NASS capacity levels, in this case the different Agricultural Statistics Capacity Indicators (ASCI). These indicators made it possible to monitor and evaluate the achievements of the objectives of the activities of the program of statistical capacity building in Senegal, comprising the development of the Strategic Plan for the Improvement of Agricultural and Rural Statistics (SPARS), the construction of a Master Sampling Frame (MSF), the implementation of multi-year integrated survey program (AGRIS), the introduction of innovative methods of agricultural data collection, including the use of CAPI Survey Solution, among others. The paper presents the results of these assessments and shows the improvement of the different dimensions of capacity of the Senegalese NASS following the implementation of these activities. Thus, the institutional dimension which was 60.7% in 2013 reached 84.3% in 2015, mainly as a result of the statistical capacity building in strategic planning of statistical activities, and this, through the development of the SPARS. Moreover, the implementation of that SPARS has propelled other dimensions, such as Statistical Methods and Practices, and Availability of Agricultural Data, for which the respective indicators have went from 52.4% to 67.3% and from 70.8% to 88.8% between 2013 and 2017, respectively. During this same period, the level of development of Senegal's SNSA has globally improved by 16.6%, from 55% in 2013 to 61% in 2015, and to 71.6% in 2017. The SPARS is also playing a major role in the mobilization of resources required for the implementation of planned activities, as evidenced by the Resource Capacity indicator, which increased by 29.4% between 2015 and 2017, from 31.6% to 40.9%. On the other hand, ASCIs play a key role in the monitoring and evaluation of the implementation of the SPARS, as they are an integral part of the Logical Framework of this Plan.

T9.3.4: Technical assistance delivery model within the framework of the implementation of the AfDB's statistical capacity building program (Abstract Id: A10-11-007)

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Agriculture is of paramount importance to Africa, as it has and will have, for the foreseeable future, a high share in the total economic outputs of most African countries. It contributes significantly to food security and a large proportion of the population of the majority of African countries is rural and depends heavily on agriculture. Therefore, the importance of the agricultural sector in Africa demands that its planning, management, and monitoring be based on sound evidence. However, most African countries do

not have an adequate system of agricultural statistics, and consequently having sustained availability of comprehensive, reliable, up-to-date, and consistent statistical data constitute big a challenge for them. In response to meeting these challenges, the African Development Bank (AfDB) has embarked on a statistical capacity building program which has also served as a basis for the implementation of the Action Plan of the Global Strategy (GS) for Improving Agricultural and Rural Statistics in Africa. Technical Assistance (TA) activities have been conducted and are currently still ongoing within the framework of that program. The delivery of TA can be done through regional training workshops and/or bilateral support to countries, including in country training, with an emphasis on a smooth transfer of know-how and using in country tailored support. Regional training workshops are cheaper than in country tailored support in terms of countries' coverage but are less effective in terms of transfer of know-how, especially if the persons attending the workshops are not the right ones. It is therefore necessary to find a balance approach that takes into account the coverage of countries and the effectiveness of knowledge transfer to them. To that end, an approach using both regional workshops and in country tailored support is presented. It comprises five main steps: (i) identification of the TA priority needs; (ii) design of TA material (curriculum, training material, tools for hands-on practice, etc.); (iii) inception regional training workshops and identification of specific countries' TA needs in the concerned topics; (iv) in country tailored support, including exploratory TA mission to countries resulting into the development of related Roadmaps, and implementation of such Roadmaps; and (v) evaluation/measuring the progress being made and impact produced, and follow up action. There are interactions among the curriculum design, the development of training material and the inception training workshop. The three form the "Learning Triangle". Each apex of the triangle may help improve the other two. To meet the challenge in attaining needed efficient knowledge transfer in order to enable African countries produce good quality agricultural statistics, the proposed approach highlights the need for the TA to be demand driven, hence a strong country political will, commitment and ownership, as we well as collaboration among the main stakeholders, regional economic commissions and countries, and building partnerships through capacity building.

Sub-Theme T10: Monitoring the SDGs

Session T10.1: Experience of statistical systems in implementing ICT tools to improve the quality of agricultural statistics for SDG monitoring

T10.1.1: Using paradata from CAPI based data collection activities to support questionnaire design and field operations monitoring (Abstract Id: A11-12-018)

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The adoption of computer-assisted data collection methods in official statistics continues to provocatively challenge the norms of the traditional pen- and-paper based methods requiring data producers to reconsider approaches used in the design and implementation of censuses and surveys.

Computer-assisted methods in many ways have shown to reorient the resource and planning requirements of large-scale censuses and surveys and at the same time bring much needed efficiencies and opportunities into the data collection process; such as increased question variety with the introduction of multimedia type questions (photo, video, geo-location), and expanded toolsets like the availability of

paradata (also commonly referred to as survey process data) allowing data producer's greater insight into the data collection process. Ever developing feature sets of popular computer-assisted data collection software packages has in particular improved access to paradata considerably – with many software packages producing it now as an automated by-product and including a larger range of variables such as the number of data entry error instances, question response times and geo-location data. While these data have remained relatively untouched by official data producers, their value is now increasing by helping questionnaire designers to better understand behavioral interactions between interviewers and respondents and through applied analyses aiding in the assessment of questions or survey instruments during feasibility testing. Past literature relating the quality assessment of measurements in questionnaire design has, however, more or less focused on the notion of question response time and the adage that a longer question response time typically corresponds with a poor question resulting in measurement issues. While question response time may certainly be considered as a valid predictor of poor question quality, it is construct that is often difficult to analyze in isolation and requires further context for interpretation. Interpretation on the quality of the question is thus taken subjectively without any rigor of analysis despite the availability of rich quantitative dataset describing other aspects of the data collection process. The following paper seeks to help formulate a systematic framework for the analysis of common paradata variables using the experience of the 2019 Bhutan RNR Census to better assist data producers in flagging potentially problematic questions earlier in their design process, and ultimately improve upon their resulting data quality.

T10.1.2: Women's ownership of agriculture land and SDG indicator 5.a.1 – Using CAPI to sample respondents in Bhutan's agriculture census (Abstract Id: A11-12-021)

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In March 2019 Bhutan conducted its third decennial Agriculture Census – known as the Renewable Natural Resources (RNR) Census – and included questions to compile SDG indicator 5.a.1, ownership or secure rights of agricultural land. The questions followed the usual pattern of proxy questions recommended by gender experts, asking about land ownership, certification, and rights to sell and/or bequeath the land in question. The questions were adapted to the language and legal context of Bhutan, where registered land ownership was introduced several decades ago, and the questions were asked of both the respondent and a randomly selected adult household member. This paper presents the results of the land ownership questions from the RNR 2019 Census, and the 5.a.1 indicator compiled. It demonstrates how the questions were adapted to the Bhutan legal context, and how tablet-based computer assisted personal interviews (CAPI) were used to select the second household respondent during the interview. It examines response differences between men and women, and between proxy and direct responses for the randomly selected household member, and provides a basis for policy measures aimed at securing equal opportunities and access to rights and resources. This also aims to explore where the country stands on the outlook of the empowerment of women and correlations between the landownership and the productivity of the household. Given the high cost of an agriculture census, this paper seeks to demonstrate how marginal increase in household coverage using CAPI based random selection can improve data on land ownership by women without significantly increasing response burden or reducing data quality.

T10.1.3: Computer-Assisted Personal Interviewing in Agriculture: A Pilot National Survey in Sri Lanka (Abstract Id: A11-12-015)

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The Department of Census and Statistics (DCS) Sri Lanka conducted the first Agricultural Household Survey (AHS) in 2017 to compile agricultural production and private food grain stock of the household sector in Sri Lanka. The field staff of the DCS would enumerate a sample of 25,000 market oriented agricultural households down from a total of about 2.9 million of such agricultural households framed in the island. Most of the surveys by DCS are still conducted through the traditional pencil-and-paper interviewing (PAPI) technique. While a lot of surveys have benefited from PAPI over the years, it has its limitations which could potentially compromise data quality. With surveys becoming more comprehensive, PAPI might be vulnerable to issues in data accuracy because of the extra effort needed by enumerators to navigate through the more complicated skips and logic built into the surveys. Meanwhile, processing the data and going through heaps of paper questionnaires with PAPI can prove time-consuming on the end of DCS. The digital age has brought forth an alternative that addresses all, if not most, of the limitations of PAPI. The computer-assisted personal interviewing (CAPI) method utilizes mobile devices instead of a paper survey to record or collect responses. In line with this development, there has been a concerted effort in Sri Lank to switch to CAPI. CAPI not only eliminate the need to manually re-enter the data, but also automates questionnaire navigation and flags inconsistent responses on the fly. Correspondingly, this paper corroborates the advantages of CAPI through a descriptive statistics comparison between the CAPI and PAPI methodologies using data from the first AHS during the Maha Season from January to June of 2017 focusing on the Anuradhapura district. Specifically, the comparison focuses on data quality, cost, and timeliness of the data collected by the two methods. The findings support the perceived benefits of CAPI in that it reduces the incidence of errors and the duration of interviews.

T10.1.4: Measuring Rice Yield from space: The case of Thai Binh, Viet Nam (Abstract Id: A11-12-016)

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Despite a growing interest in using satellite data to estimate paddy rice yield in Southeast Asia, significant cloud coverage has led to a scarcity of usable optical data for such analysis. In this paper, we study the feasibility of using two alternative sources of satellite data—(i) surface reflectance fusion data which integrates Landsat and Moderate Resolution Imaging Spectroradiometer (MODIS) images, and (ii) L-band radar backscatter data from the Advanced Land Observing Satellite 2 (ALOS-2) PALSAR-2 sensors—to circumvent the cloud cover problem and estimate yield in Thai Binh Province, Viet Nam during the second growing season of 2015. Our findings indicate that although Landsat– MODIS fusion data are not necessarily beneficial for paddy rice mapping when compared with only using Landsat data, fusion data allows us to estimate the peak value of various vegetation indexes and derive the best empirical relationship between these indexes and yield data from the field. We also find that the L-band radar data not only has a lower performance in paddy rice mapping when compared with optical data, but also contributes little to rice yield estimation.

T10.1.5: A big data approach to identifying and modelling triggers of agricultural efficiency for sustainable development (Abstract Id: A11-12-019)

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All 17 United Nation's Sustainable Development Goals (SDGs) are defined with measurable aims for improving our quality of life. Each can be viewed as a potential data source for national development strategies, business improvements and practical data modelling. Their complex overlap provide both challenges and opportunities in identifying and modelling important data attributes relating to environmental protection, human livelihood and global sustainability. Research communities across disciplines and regions are called upon to engage in unified initiatives for identifying data challenges and opportunities, tools and methods for addressing them. Many parts of the development world still face challenges relating to SDGs 1 and 2 which trigger other issues such as environmental degradation and inequality. As peoples' welfare is directly tied to the productivity of the resources at their harvest, a good understanding of the factors that impinge on agricultural productivity is crucial. Such knowledge derives from interactions of data attributes–natural, technological and legislative. Data on local, regional and global conditions - rainfall, soil fertility, crop rotation, number of field officers, market access, food storage methods etc, are key predictors of agricultural output. Subtly associated factors like the general health of the population, education, state of the environment and political stability also significantly and cyclically impinge on agricultural output, food security and nutrition. Agricultural innovation and productivity as composite functions of data attributes form a knowledge-based operation, driven by science, technology and innovation (STI), deriving from interacting triggers of a variety of SDG indicators. While we have seen a number of high-level initiatives and publications on SDGs in recent years, research work on identifying triggers of SDG indicators is still in its infancy. The recent publication of the SDGs Atlas by the World Bank and tools like \href{url}{\textcolor{blue}{https://www.millennium-institute.org/isdg}}, developed by the Millenium Institute, provide descriptive statistics and simulated patterns respectively that are vital in understanding the levels of agenda 2030 attainment globally. However, in addressing real-world challenges, computational, statistical and analytical skills are mere tools that we need to address practical problems, such as agricultural productivity, which heavily relies on what happens across other SDGs. We propose a data driven approach designed to add a predictive power to existing statistical tools. We set off from the premises that we are currently generating more data than we can make sense of while at the same time we are witnessing increasingly great innovations in data acquisition and modelling, through Machine Learning (ML) and Artificial Intelligence (AI) techniques. Viewing each SDG as a Big Data node and the entire set of 17 as a multi-disciplinary data fabric, we combine unsupervised and supervised techniques to detect and model potential triggers of agricultural efficiency. Data from three African countries portray a deep and wide diversity across the continent, entailing unified and more co-ordinated activities. Results show that the challenges and opportunities are pathways towards addressing issues ranging from data infrastructure, governance, sharing, modelling and security, potentially influencing policies and improving decision making at all levels and creating a Development Continuum (DC).

Session T10.2: Role of Private Sector in Promoting New Technology for Agricultural Statistics to Enhance SDG Monitoring

T10.2.1: Crop monitoring in central and west Asia utilizing satellite optical and radar data (Abstract Id: A12-13-025)

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Earth Observing System (EOS) is a US-based company which provides a unique solution in EO imagery processing and analysis. Automated on- the-fly processing, data agnosticism, own cutting-edge methods and algorithms and ability to use third-party data allows EOS to position itself as the market-leading geospatial business solutions provider. In 2018, the firm implemented a number of projects, including "Kazakhstan Gharysh Sapary" (Kazakhstan), Azercosmos (Azerbaijan). The EOS Data Analytics performed the following work blocks in 2018 within each project: crop classification; crop conditions assessment; yield forecast; harvest dynamics monitoring. An important economic indicator for each country is the territorial location and availability of agricultural land. The EOS company has developed its own crop classification method based on an ensemble of neural networks and in-depth training using satellite data. The satellite forecast of main agricultural crops yield is carried out based on up-to-date Earth remote sensing data of medium and low spatial resolution, meteorological data with NASA's Modern Era Retro-analysis for Research and Applications assimilation model based on temperature, precipitation, wind speed, solar radiation, partial pressure data, as well as archival statistical and phenological data. Crop condition is estimated based on vegetation indices calculated from Sentinel-2, Landsat 8, MODIS satellite data, as well as high spatial resolution imagery. A peculiarity of cropland events monitoring task is the necessity to build a dense time series of satellite surveys with high spatial resolution. Sentinel-1 SLC space radar survey data with a spatial resolution of 10 m allow to track the earth's surface and vegetation cover changes (crop growth, drying, cultivation, harvesting and precipitation) from backscatter coefficient and coherence maps. Sentinel-1 SLC images with time resolution of 12 days were used for harvesting monitoring in northern oblasts of the Republic of Kazakhstan from 01.08.2018 to 09.11.2018. Harvesting dates were found for 82445 agricultural lands with a total area of 17.6 million hectares located in the territory of Akmola, East Kazakhstan, Kostanay, Pavlodar, North Kazakhstan oblasts. The main difficulty in forming of satellite observations regular time series was a presence of gaps in survey dates and the presence of areas not covered by the survey. To compensate time gaps the C-band RADARSAT-2 satellite images can be used, which, like the Sentinel-1, perform survey in VV and VH polarizations. The main crops were identified in 2018 by classification for the territory of Azerbaijan using optical surveys data. Due to the small area and narrow oblong shape of Azerbaijan croplands is, the SPOT satellite constellation data was used for solving the classification problem

T10.2.2: JAXA's contribution to agricultural and rural statistics (Abstract Id: A12-13-023)

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The Japan Aerospace Exploration Agency (JAXA) was formed through the merging of three institutions, namely the Institute of Space and Astronautical Science (ISAS), the National Aerospace Laboratory of

Japan (NAL) and the National Space Development Agency of Japan (NASDA). It was designated as a core performance agency to support the Japanese government's overall aerospace development and utilization. JAXA, therefore, can conduct integrated operations from basic research and development to utilization.1 JAXA performs many activities, including projects related to earth observation for crop monitoring. The organization puts emphasis on international cooperation and strives to make contribution towards the greater goal of creating societies where the governments of various nations of the world, international organizations and private enterprises can make decisions effectively and efficiently for crop production, food trade, subsidies, and subsequently, food security. Timely and reliable data are prerequisites for evidence-based decisions, and this can be achieved through scientific and objective measurement of crop growing conditions. JAXA Earth Observation Research Center (EORC) specializes on this field and prioritizes research and development on tools and methodologies for crop monitoring and forecasting crop yields using observation data and models in cooperation with related research organization. Important crop parameters include the area of production, growing conditions, volume of harvests, among others, which are used in many studies and policies by research organizations and government agencies in and out of Japan.2 Though most of JAXA's works are not directly aimed to improve agricultural statistics, their works related to climate change enable quick responses to a variety of situation affecting agricultural productions. In line with this, JAXA has developed a software INternational Asian Harvest mOnitoring system for Rice (INAHOR), a software application developed for estimating rice crop area and production using radar satellite imagery. INAHOR uses data from the L-Band Synthetic Aperture Radar (PALSAR-2) on the Advanced Land Observation Satellites "DAICHI 2" (ALOS-2) operated for two or more time periods. The use of radar satellite data is more advantageous for observing areas that are heavily covered with clouds. This remains an issue for earth observation especially during the rainy season in areas such as Southeast Asia—a major paddy rice production base in the region. 3 INAHOR has been used to identify and estimate paddy area using ALOS-2 satellite images. JAXA continues to develop and improve tools such as INAHOR that would contribute to the improvement of agricultural statistics in the region. JAXA’s works in recent years related to climate change also enable quick responses to a variety of situation affecting agricultural productions using ALOS-2 and other earth observation satellites.

1 https://global.jaxa.jp/about/jaxa/index.html

2 https://www.eorc.jaxa.jp/en/earth_observation_priority_research/agriculture/

3https://www.adb.org/sites/default/files/publication/496976/remote-sensing-paddy-area-productionhandbook.pdf

T10.2.3: Satellite-based technology applications to aid agricultural and rural statistics (Abstract Id: A12-13-024)

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The Remote Sensing Technology Center of Japan (RESTEC) has more than 30 years of experience in various applications of data from earth observation satellites to address a wide range of demands from users from both Japan and overseas. Changes in the land cover and vegetation, atmosphere, and water resources are important parameters to understand critical issues about the environment and natural resources. With appropriate software applications and satellite imagery, innovative and cost-effective approaches could be developed to measure these parameters, and eventually use for policymaking in a reliable and timely manner. In Japan, RESTEC has developed an empirical methodology to estimate the production of rice for each province. The agency has also supported two projects of the Asian Development Bank (ADB): (i) Innovative Data Collection Methods for Agricultural and Rural Statistics and (ii) Applying Remote Sensing Technology in River Basin Management. The first project aimed to build the capacity of national statistics offices (NSOs) on the use of remote sensing as a data collection

tool to further improve the quality and timeliness of rice crop area and production. RESTEC worked with four major rice-producing countries in Southeast Asia—Lao People's Democratic Republic, the Philippines, Thailand, and Viet Nam and explored efficient methods for reliable and more-frequently measured rice statistics. The other project with ADB, on the other hand, dealt with developing application for water-related disaster mitigation. RESTEC will present case studies and best practices which highlight the important role of space-based technology in various applications. The agency's many years of experience showcased how space-based technologies have been successfully applied in many disciplines, including agricultural and rural statistics. Aside from the work done with ADB, RESTEC will also introduce cutting-edge tools and/or solutions on disaster monitoring, land use and land change, agriculture (e.g. major crops such as rice, maize, and sugarcane), forest monitoring, and land cover classification. RESTEC will also present their experiences and the challenges encountered during field survey using micro-satellite constellation service and cloud-based service platform , which are promising tools to aid data collection and management in the modern agriculture sector. With improved data collection system, policy makers and government planners can apportion resources well, reduce vulnerability, and assess the effectiveness of policies and programs for the sector.

T10.2.4: Measuring agricultural sustainability impact using causal / bayesian analysis on socioeconomic and biophysical parameters (Abstract Id: A12-13-026)

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Sustainable agriculture is the aggregation of all activities directed towards the efficient production of high-quality agricultural produce by ensuring that the practices employed will protect and improve the natural environment, the socio-economic status of the farmers, local communities and other stakeholders. In order to understand sustainability, different indicators that contribute to sustainable agriculture need to be monitored and measured in an efficient manner. The sustainability indicators of a farming activity are characterized by socio-economic, biophysical and environmental dimensions of farmers and the social network through which the market and crop knowledge is disseminated to the farmer. Hence, each indicator has its own implications and significant role in the sustainability chain, e.g., the economic status and educational background of the farmer decides the management practices that the farmer is following. On the contrary, the profit of the farmer is decided by the marketing decisions and timely information provided by the agricultural experts. Thus, sustainability does not depend only on a concise set of indicators, rather, it is decided by multiple parameters at different levels in a complex system. There are comprehensive studies conducted by researchers on a variety of indicators, where they have formulated the metrics using statistical and econometric models. The available metric studies are limited to the usage of socioeconomic and ecological indicators. This analysis would potentially give a synoptic idea about the relationship between the indicators and their impact on sustainability. There are very limited studies that have utilized biophysical and environment parameters extracted from remote sensing satellite imagery and observed their relationship with socio-economic parameters. The dynamic nature of sustainability indicators over time and space causes diversified and complex issues in measuring agricultural sustainability. This paper proposes a hierarchical approach to understand the issues in agriculture sustainability at the following levels: farmer, field extension and government official. This can be addressed by network relationship studies which provide generic stages of the chain of events that can represent the root cause of the issue. It is proposed to use causal/Bayesian network algorithm approach to build a relationship between the indicators. The causal network relationship model traverses through each transition in the chain and accumulates its effect at each level that could be attributed to the metrics. Rather, Bayesian network model is a probabilistic framework that aims to model the conditional

dependence between all the important variables through which it produces the metric relationship. Utilizing various parameters digitized from farmers, agronomists and experts, hierarchical impact metrics model is developed to measure sustainability efficiently and monitor the impact of work done for the livelihood of farmers.

Special Session T11.1: 2nd Phase of Global Strategy