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GHANA FEED THE FUTURE AGRICULTURE POLICY SUPPORT PROJECT (APSP)

Review of Data Collection Methodologies and Analyses at the Statistics Research and Information Directorate (SRID) of the Ministry of Food Agriculture (MoFA) and Remedial Actions

Contract No. 641-C-14-00001

USAID

FROM THE AMERICAN PEOPLE

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Table of Contents

List of Acronyms

AfDB	African Development Bank
APD	Animal Production Directorate of MoFA.
APSP	Agriculture Policy Support Project
AU	African Union Commission
CEPA	Centre for Economic Policy Analysis
CPI	Consumer Price Index
CPO	Crude Palm Oil
CSD	Crop Services Directorate of MoFA
CSIR	Council for Scientific and Industrial Research
CTA	Chief Technical Advisor, MoFA
DoA	Department of Agriculture
DDA	District Department of Agriculture
EA	Enumeration Area
FAO	Food and Agriculture Organization of the United Nations
FFB	Individual Fresh Fruit Bunches
GAPS	Ghana Agricultural Production Survey
GCNet	Ghana Community Network Services Limited
GDP	Gross Domestic Product
GEPA	Ghana Export Promotion Authority
GPHA	Ghana Ports and Harbours Authority
GPS	Global Positioning System
GSA	Ghana Shippers Authority
GSS	Ghana Statistical Service
IFDC	International Fertilizer Development Company
IFPRI	International Food Policy Research Institute
IITA	International Institute for Tropical Agriculture
KNUST	Kwame Nkrumah University of Science and Technology
LER	Land Equivalent Ratio
LGS	Local Government Service
MoFA	Ministry of Food and Agriculture
MRACLS	Multi-Round Annual Crop and Livestock Survey
OPRI	Oil Palm Research Institute
PPMED	Policy, Planning, Monitoring and Evaluation Division
PPRSD	Plant Protection and Regulatory Services Directorate of MoFA
SARI	Savanna Agricultural Research Institute
SRID	Statistics, Research and Information Directorate of MoFA
TOR	Terms of Reference
UNECA	United Nations Economic Commission for Africa
USAID	United States Agency for International Development
VC	Value Chain
VSD	Veterinary Services Directorate of MoFA

Executive Summary

Data is generally considered high quality if they correctly represent realities and are well-tailored to inform policy and business decisions. Accurate farm gate prices and agricultural production data are required by the Ghana Statistical Services (GSS) for calculating the country's gross domestic product (GDP). Retail market price data on food crops is also used for calculating the consumer price index (CPI). The GDP and CPI are of high importance for policy and business decisions, both at the national and international levels.

The GSS relies on the Statistical, Research and Information Directorate (SRID) within the Ministry of Food and Agriculture (MoFA) for farm gate prices and agricultural production data. SRID is mandated to collect data and provide reliable, relevant and accurate agricultural statistics to various end users. However, as with many African countries, deficiencies in the accuracy and robustness of data and statistics on the agricultural sector have been noted in Ghana. These deficiencies informed the need for this consultancy. The aim is to review and improve methodologies for data collection and the presentation of statistics by SRID.

The approach used for this assignment involved a review session with SRID personnel, of protocols and manuals used by SRID to guide primary data collection. Methodological deficiencies noted in SRID's primary data collection processes must do with yield estimation, and reliance on surveys to collect farm gate prices that are possibly not observed during surveys. Flaws noted in the generation and presentation of metrics are:

- Presentation of 'average' without sample size and measures of dispersion around the mean;
- Estimation of data on individual oil palm production;
- Misrepresentation of per capita stocks of food commodities from production and imports, without adjustment for losses in storage, as per capita food consumption;
- Presentation of aggregate production data for key crops which have significant price differentials for major varieties;
- Unscientific handling of outliers that do not result from errors in coding or data entry; and
- Incomplete clarity on 'potential' and 'achievable' yields.

The weaknesses in institutional linkages and arrangements led to non-harmonization or triangulation of disparate imports and exports data held by different possible sources of secondary data. Similarly, there is lack of coordination, particularly with GSS, in the collection of retail prices for food items used for computing the CPI. There is also lack of timely access to secondary data, as well as weak methodologies used to collect the data from MoFA directorates. Based on the identified deficiencies, urgent steps in three key areas on the part of MoFA (as supervising Ministry) and SRID, are recommended. These should involve:

- Specific changes in primary data collection methodologies;
- The generation of relevant metrics and their dissemination and;
- The resolution of institutional issues including having links to sources of similar and secondary data.

First, the recommended changes in primary data collection methodologies must include the following:

- A change from current practices (under MRACLS and GAPS) of selecting single sample site per farm for yield estimation to a purposive equipment-based selection of sites that is consistent with observed broad heterogeneity on farms or the selection of yield sites along transects to reflect observed heterogeneity on farms.
- A change from the routine selection of 5 farmers per zone in 40 zones per district to statistically-defendable sample size selection using Slovin's formula to determine total sample size per district

and then purposively allocating the sample to ensure representativeness of the crop's production potentials in a district.

- For each crop, a network of linked markets and market participants must be selected and then prices and service costs should be collected along the chain from rural assembly points to consumer level. Simple formula in SRID's marketing survey protocol should be used to calculate farm gate prices (which are usually unobserved since sales period are sometimes different from survey times).
- Change is required in the presentation of national oil palm production based on using only data from few known large companies. SRID should use field level estimation of area under cultivation and yields, methodology from OPRI of CSIR. This recommendation is particularly relevant for oil palm production outside the purview of the large companies.
- SRID should also generate database on actual cropping areas for different crops, farm gate prices and key seasonal rainfall indices that motivate farmer cropping decisions. Then, it should use simulation on the time series database on area planted to different crops and associated key indicators of performance of the rainy season to generate cropping scenarios based on pricing and meteorological predictions on the rainfall pattern.
- Scientific robust techniques should be deployed by SRID to identify and handle suspected outliers that do not result from errors in data entry or coding.

Secondly, recommended changes for the generation and presentation of metrics should include the following:

- It must be admitted that the allocation of the same land area to crops grown in relay or rotation at plant densities for sole crops is correct. However, in mixtures, which involve true intercrops, cropping densities of the component crops are lower than densities under sole cropping for the same crop and location. Land area allocation should be based on cropping densities proportions for each component crop in sole cropping and intercrops.
- There is also the need to move beyond current SRID practice of calculating and presenting only 'average' or 'mean's to providing additional information on measures of dispersion around the mean and the sample size used.
- A change is required from reporting average or mean market prices based on a survey of 3-5 persons to reporting most quoted commodity prices in selected markets. However, where the average price per unit is desired, the measures of dispersion around the mean and the sample size should be reported as well.
- In the absence of actual household surveys to estimate per capita consumption, SRID should replace the misleading heading in its publication on facts and figures with 'Per Capita Food Availability from Food Stocks' (production plus imports). It is important to note that due to losses (to pests, damage etc.) in storage, the total food stocks need to be adjusted by estimated percentage losses in storage.
- SRID should separate, where necessary, commodities into categories that are useful to guide business and policy decisions. For example, bulked rice data could be split into aromatic and non-aromatic, sorghum data into red sorghum and white sorghum, and yam into two categories (1. high valued 'poona' and 'labreko'; and 2. low priced white yam).

Thirdly, recommended next steps in strengthening institutional links with institutions collecting similar data or providing SRID with secondary data are as follow:

- SRID, in collaboration with GSS, should initiate periodic inter-agency meetings to review data collection methodologies, accuracy, and then triangulate and harmonize data on agriculture exports and imports. The inter-agency consultation currently used to review and harmonize data on fertilizer imports provides a pragmatic useful example.

- SRID should consult with GSS and private entities to harmonize methodologies for collecting market price data on agricultural produce, types of data collected and areas of intervention to save resources.
- The senior management of MoFA should put in place and implement an institutional mechanism that makes it mandatory for all directorates of MoFA to transmit data collected to SRID.
- It is also recommended that the senior management of MoFA provide specific mandates along with guidelines and timelines (e.g. quarterly, bi-annually or annually) for copies of data collected by all Directorates of MoFA, and the methodologies used to collect the data, to be transmitted to SRID.
- Also, MoFA senior management should engage their counterpart at the Ministry for Local Government and Rural Development to agree on a mechanism to facilitate SRID supervision of field staff that collect data in the Department of Agriculture in the Districts/Municipalities/Metropolitan areas.

1.0 Background

Globally, there is a marked decline in the availability and quality of agricultural statistics (The International Bank for Reconstruction and Development / The World Bank, 2011). It is therefore, not surprising that many African countries lack adequate systems to collect, store and disseminate data on the agricultural sector (AfDB/AU/UNECA/FAO, 2011). However, due to the importance of agriculture for African economies, it is imperative for countries to strengthen agriculture sector data for analyses to inform policy and business decisions.

In Ghana, the Ghana Statistical Service (GSS) needs farm gate prices and agricultural production data when calculating the gross domestic product (GDP). Also, market price data for food crops are used in calculating the consumer price index (CPI). Data are generally considered high quality if, "they are fit for their intended uses in operations, decision making and planning" (Redman, 2008, p.56) or if they correctly present realities. Both GDP and CPI are examples of indices that require a high degree of accurate and robust data.

The Statistical, Research and Information Directorate (SRID) of the Ministry of Food and Agriculture (MoFA) is mandated by MoFA to provide reliable, relevant and accurate agricultural statistics to end users, to inform policy and business decisions. In pursuit of its mandate, SRID collects and analyzes relevant primary and secondary agricultural data in Ghana. The primary data collected cover local food crops, livestock, and market prices. Presently, SRID does not cover all food crops and important cash crops such as cotton. This shortcoming has negative implications for capturing the agriculture sector's contribution to GDP adequately. Data on agricultural inputs, food imports, non-traditional crop exports etc. are obtained by SRID from other institutions.

During primary data collection, SRID mainly uses Multi-Round Annual Crop and Livestock Survey (MRACLS) and improved protocols under the Ghana Agricultural Production Survey (GAPS) project. The Marketing Services Unit of SRID uses a well laid out protocol to collect wholesale and retail price data from 178 selected domestic markets. Secondary sources of data (on local livestock, food imports and agricultural inputs, and non-traditional agricultural exports) include GSS, Ghana Export Promotion Authority (GEPA), Veterinary Services Directorate (VSD) of MoFA, Crop Services Directorate (CSD) of MoFA, and the Plant Protection and Regulatory Services Directorate (PPRSD) of MoFA.

In pursuit of its data collection mandate, SRID has received technical or funding support from governments and donor organizations. It has also been given technical assistance from FAO (Food and Agriculture Organization) and IFPRI (International Food Policy Research Institute). For example, with technical assistance from IFPRI, SRID initiated a pilot project known as the Ghana Agricultural Production Survey (GAPS) to address methodological and data management limitations noted in MRACLS and the revised protocols are documented in a reference fieldwork manual (SRID, 2011). The manual covers field data collection protocols, data review, and data entry methodologies. A publication, (MoFA-SRID, 2015), entitled "Agriculture in Ghana: Facts and Figures (2013, & 2014)" contains examples of summary agricultural statistics from both primary and secondary sources.

Findings from interviews and interactions with SRID staff and stakeholders revealed that lingering questions remain about the accuracy, quality, and robustness of some data collected, documented and published by SRID. Concerns have also been raised by various stakeholders including MOFA management on the accuracy and reliability of SRID data. In fact, the concern points to the methodologies used in generating available data. These concerns necessitated this consultancy.

During a discussion with SRID management and staff, it was revealed that methodological limitations undermine the capacity to generate robust data to support policy and business decisions. However, SRID

personnel indicated that the lack of adequate resources explains why they continued with certain methodological practices although they were inappropriate. An example given was that with the end of project funds that supported data collection and management, there was a reduction in the sample sizes that are usually used during primary data collection.

1.1 Objective

This consultancy, as per the terms of reference (TOR) in Annex A, aims to review SRID's data collection methodologies and data analyses. It also aims to propose methodological improvements to increase data quality and robustness, and to analyze those methodological approaches that would enhance the confidence and the presentation of agricultural statistics.

1.2 Methodology

The approaches adopted in the implementation of the tasks assigned include reviews of primary and secondary data types and methods used by SRID, interactive discussions with personnel of organizations providing secondary data to SRID, and a review of relevant literature. The detailed meetings are listed below:

- Preparatory meetings were held with officials of CEPA (Centre for Economic Policy Analysis), Chief Technical Advisor (CTA) to the Minister of Food and Agriculture, and the Agriculture Policy Support Project (APSP) Advisor at MoFA. The objective of the meetings was to seek clarifications and practical guidance on the terms of reference (TOR) for the consultancy.
- A meeting was held with the Director, Deputy Director and senior staff of the Statistics, Research and Information Directorate (SRID) of MoFA.
- Based on the initial set of interactions, an inception report was prepared and delivered within a week, as required in the TOR for the consultancy. The inception report contained the workplan (Table 1) covering the period of the consultancy.
- Substantive technical meetings were held with Heads of units responsible for data collection and management at SRID namely: Production, Marketing Services Unit, and Information and Communication Unit. Data types (primary and secondary) collected by SRID, the sources of the data (Table 2) and the methodologies used to obtain primary data were reviewed.
- Options for improving the quality and robustness of data collection methodologies and presentation were discussed as part of the review process. Feedback was sought on resource (funds, equipment) implications and feasibility of specific quality improvements in proposed methodologies.
- District-level consultations were held with officials of the Akuapem South District Department of Agriculture at Nsawam. The objective of the visit to Nsawam was to discuss protocols followed and methodologies used by frontline staff during primary data collection in the field. The interaction, with the frontline enumerator, the Municipal Information Services officer and the District Director for the Department of Agriculture (DoA) of the Local Government Service (LGS), provided insights into the field-level implementation of primary data collection as well as institutional arrangements and their implications for ensuring robust data collection. The latter is important because although there are dual links between the District Department of Agriculture and the District/Municipal/Metropolitan Assemblies on one hand and SRID on another hand, the annual planning and supervision are situated within the District/Municipal/Metropolitan Assemblies.
- Institutions that provide or have the potential to provide secondary data to SRID (PPRSD, CSD, VSD, GEPA, Ghana Shippers Authority [GSA], GSS and Ghana Harbours and Ports Authority [GPHA]) were visited. Discussions held with officials of the institutions focused on seeking to understand the types of data and methodologies used to generate data from their primary collection points, as well as to determine accuracy checks and the reliability or robustness of procedures used.

- Proposals for methodological improvements, including case studies, were included in a draft consultancy report that was shared with SRID Director and technical guidance group, for feedback. Based on two rounds of feedback, the draft report was appropriately revised.
- A presentation on the consultancy was held on 15th July, 2016.
- The finalized consultancy report was submitted to CEPA and members of the technical guidance group (SRID, MoFA, and USAID/APSP).

2.0 Results and Discussions

The assessments made were based on discussions on the contents of documents provided by SRID (copies of MRACLS & GAPS, marketing protocols and two publication of "Agriculture in Ghana: Facts and Figures") for 2013 and 2014.

2.1 Primary Data Collection

2.1.1 Production Data

The primary production data, from MRACLS, focus on 11 key staples namely maize, rice, sorghum and millet (cereals category); plantain, cassava, cocoyam, yam (roots, tuber, and banana category); and groundnut, soybean and cowpea (legumes category). During the initial field data collection, a survey questionnaire is used, prior to the beginning of the major growing season, to elicit cropping intentions. The survey steps include the mapping (listing) of farmers and the crops they intend to produce in the cropping season. Forty (40) Enumeration Areas (EAs) are selected per district out of the total number of EAs demarcated by the GSS in each district. The 40 EAs would give SRID enough data for calculating 'average' production for a district. If the district-level production data calculated for the 40 EAs per district are to be used subsequently to calculate 'national average' production, then it becomes necessary to assign weights to the district-level production data, using proportional district production levels as weights. However, it is not clear why the number of EAs are not selected proportionally to the number of EAs in the different districts. The application of Slovin's formula is recommended for more scientific sampling or selection of sample EAs based on 99% or at least 95% confidence level.

The field data collection is done by trained personnel (district agricultural agents) of the District Department of Agriculture (DDA) and supervised by the Director in charge of the DDA. SRID personnel do review data submitted from the districts and send back questions on data they deem 'suspicious'. However, the procedure for identifying 'suspicious data' is not well understood in the district visited. This observation is based on an instance where SRID staff 'adjusted' data deemed to be outside the 'norm'. The methodology for adjusting data collected by field enumerators should be well documented and based on a solid statistical foundation.

Under the country's decentralization policy, all government departments and agencies in the districts come under the supervision of relevant District/Municipal/Metropolitan Administration. Under this arrangement, SRID has no specific leverage on personnel of the Department of Agriculture that collect data in the field except moral persuasion or through personal links. This data collection and supervision arrangement has important implications for the quality control and verification of accuracy. MoFA senior management should establish formal supervision mechanisms with the Ministry of Local Government and Rural Development to ensure that this data collection process and its concomitant supervision takes place.

Methodologically, the field enumerators randomly select 5 farmers per enumeration area. Therefore, for the 40 enumeration areas per district, a total of 200 farmers are covered. It was explained by SRID personnel that 2 out of the 5 farmers selected from each enumeration area come from the same household. There was no explicit reason for this practice but the practice implicitly assumes that there is both intra-household and inter-household variability. Based on the definition of a household in terms of

the use of common resources, the assumed intra-household variability, if not gender or age-group based, needs to be tested for significance and if not significant then this practice of selecting 2 farmers from the same household should be discarded.

SRID's reliance on random sampling as the methodology for selecting farmers, farms and respondents assumes normal distribution or errors. The selection of only 5 farmers per enumeration area, irrespective of the total number of farmers/respondents and farms listed for a crop in an enumeration area and district, raises questions about the representativeness of the farmers/respondents and their farms. In addition, the equal treatment of all the 40 enumeration areas within a district and the averaging of data collected from them to derive district average raise important questions on representativeness and robustness. Compounding this flaw is the reporting of 'average' or 'mean' without any associated measures of dispersion such as standard deviation and minimum and maximum ranges. Also, the selection of 200 farmers (5 farmers x 40 enumeration areas) in each administrative district has unintended implicit uniformity assumptions across districts that do not stand up in terms of evidence or rationale. These methodological questions have important implications for the representativeness, reliability, accuracy and robustness of the district 'average', and subsequent national 'average'. It is recommended that SRID reviews carefully its methodological approaches in sampling to ensure representativeness of EAs, farms and farmers covered in a district.

As indicated earlier, Slovin's formula should be used to determine the sample sizes from the total EAs per district determined by GSS. Also, the sample size in each district needs to be based on its proportion to the total sample frame for all farmers of any crop. Case study 1 (in Appendix 1) provides an example of the use of Slovin's formula, assuming lack of prior knowledge of characteristics of underlying data, to determine sample size from the mapping of farmers and their crops which take place during MRACLS or GAPS, based on acceptable level of confidence (1% or at most 5% error).

There are several online tools for calculating sample size. For example, this online toolkit [http://www.nss.gov.au/nss/home.nsf/pages/Sample+size+calculator] is provided by the National Statistical Service of Australia.

Crop production intentions data are collected early in the season as part of the multi-round annual survey. Since crop production in Ghana is still dependent on seasonal rainfall, SRID should not use the crop intentions data for projections. If SRID desires to make crop production projections for each season, SRID should build a time series database comprising actual land areas cropped, farm gate prices and indices of seasonal rainfall which inform farmer crop choice and land allocation decisions. SRID can then conduct scenario analyses based on simulation exercises on the time series database. Farm gate prices and data from the meteorological services department or field offices of Department of Agriculture in the districts, where rainfall data are measured and documented, would provide the required time series database.

It was noted that the primary production data collected did not distinguish between major categories/varieties of crops. For example, red and white sorghum were simply put together as sorghum. Similarly, perfumed and non-perfumed rice were simply presented together as rice. Also, yam was simply assumed to be 'white' yam and the low price of white yam was wrongly used for valuation of yam production. SRID should adjust in its survey questionnaire, data coding and data entry to allow distinctions which are important for policy and business decisions.

Land area measurement and Documentation

SRID relies mainly on land area measurements conducted with the aid of a global positioning system (GPS) equipment. The human resources requirements of the direct land area measurements limit the total area that could be covered by SRID. Complementing field-based area measurements with remote sensing

would improve accuracy and measurement of the total land area covered nationally by cultivated crops or individual crops.

Increasingly, remote sensing, through which crop yield can be estimated based on spectral reflectance of green plants, is likely to feature as the basis for generating agricultural statistics in the future (Zhao et al., 2007). Spectral data are used to construct vegetation indices such as normalized difference vegetation index (NDVI) which indicates the green biomass that can be used as a proxy indicator of the yield (Prasad et al., 2006). However, lack of sufficient details to capture crop variability, particularly on small farms and intercrops, from available satellite resolution constitutes important limitations to the use of satellite images to estimate crop yields of smallholder farmers. Also, although SRID has remote sensing equipment, it is not currently functional. For these reasons, SRID would have to continue to rely on field-based measurements of land area under crops.

Based on in-depth discussions on the field-based area measurement methodologies for crops, it is important to note the distinctions that are relevant to the allocation of land area to mixed crops on farms. SRID and the field staff who do the area measurements need to distinguish between two different types of crop mixtures:

- Farms on which the growth stages of the component crops in the mixtures portray relay-cropping or crop rotation and;
- Farms on which the stages of growth of the components of the mixtures indicate true intercrops.

In cases where component crops are in relay-cropping at densities that are consistent with sole cropping, the total land area can be allocated to each of the component crops. In cases of crop mixtures that are intercrops of component crops at lower densities than when grown as sole crops, it would be wrong to allocate the total farm size to each of the component crops.

Case study 2 (in Appendix 2) presents a methodological approach which would reduce over-estimation of total land area cultivated to intercrops and to individual crops within intercrops. In the case of intercrops, it is recommended that SRID document the following data:

- Actual farm land area for each crop grown as sole;
- Actual land area intercropped;
- Farm-level densities of each of the component crop in the intercrop and;
- Farm level cropping densities for each sole crop in the same locality.

It is important to use the proportional crop densities to calculate the proportion of farmland occupied by each of the component crops and then calculate the land equivalent ratio.

Crop yield estimation

The concept of crop yield generally represents the average amount of produce obtained per unit of the crop area, while production shows the total amount produced (FAO 1982). Many agricultural surveys typically record crop area as the planted area instead of a harvested area. However, as Casley and Kumar (1988) point out, the harvested area is always the most relevant measurement for recording crop area and estimating crop yield at the plot level. This is because harvested area may be equal to or less than the planted area. It provides reliable and accurate yield and production estimates. Martinez et al. (2015) and European Union (EC) Regulation No. 543/2009 on crops statistics define harvested area as the part of the field sown or the planted area that is harvested. Under methodology used by SRID, there was no mention of estimates of yield losses on-farm (from pest and diseases). However, if the yields are recorded at

harvest times, then there will be less concern about the lack of accuracy due to field crop losses. The estimation of harvested area and yields would correct possible overestimation even without adjustments for field crop losses.

A methodological concern was the random selection of one yield plot per farm for yield measurements, under MRACLS and GAPS. Under the pilot GAPS, the plot size for plantain, for example, is 9m by 9m and cereals (excluding rice) is 6m by 6m. The GAPS equipment-assisted methodological improvement in area estimation only corrects for bias in the selection of the yield plot. It also uses a random selection of the initial point from where the equipment assists in locating other coordinates. Therefore, the yield estimation methodologies used in both MRACLS and GAPS do not account for heterogeneity on farms due to differences in resource quality or management. The remedial methodological approach is to locate miniature yield plots along transects across farms or to purposively select proportional location of yield plots to account for heterogeneity on farms. Case study 3 (Appendix 3) presents a recommended purposive approach to yield estimation to account for heterogeneity on farms. Methodologies for estimating area cultivated and yields of oil palm are also presented as case study 4 (Appendix 4).

Yield data submitted from the district to SRID that are suspected to be outliers are 'adjusted' by SRID. Explanations were provided on the processes used for the 'adjustment' of data deemed to be outliers. SRID does not use the same procedure to treat outliers but takes them each in its context. After identifying an outlier, SRID explores the data further to understand the underlying causes which then inform how to treat/manage it. In some cases, outliers resulted from poor data collection or entry and were corrected after field investigations. In other cases, outliers were replaced with estimated values (e.g. group mean or median) or declared as missing values when the outlier prevalence is less than 5% of the data values. The problem is with how SRID identifies and manages suspected outliers which are not due to coding or data entry errors.

There is a wealth of literature on the detection and treatment of suspected outliers. If the outlier resulted from incorrect coding or data entry, then the error can be corrected based on evidence from field checks. If the outlier resulted from wrong measurements, then it is bad data and should be deleted from data for analysis. In some cases, it might not be possible to determine from field and data entry checks that an outlier is bad data. Some outliers may suggest random variation or some interesting cases (after outlier labeling) for further scientific investigation. Typically, outlier observations are not simply deleted. There are robust statistical techniques for dealing with outliers. Identifying an observation as an outlier depends on the underlying distribution of the data. If univariate datasets are assumed to follow approximately normal distribution, then it is possible a suspected outlier points to non-normality of the data.

Therefore, a good procedure to follow is to generate normal probability plot of data before applying outlier tests. In addition, the lower and upper tails of the normal probability plot provide graphical techniques for identifying potential outliers. Also, box plot and histograms are recommended graphical tools for checking normality and identifying suspected outliers. More in-depth discussions on detection and treatment of outliers can be found in Barnett and Lewis (1994), and in Iglewicz and Hoaglin (1993).

2.1.2 Primary Marketing Data

SRID collects market prices for selected food crops at wholesale, retail, and farm gate levels. Weekly market price surveys are conducted in 178 markets nationwide, including selected markets in all the 10 regional capitals as well as Tema, Techiman, Obuasi, Mankessim and Ejura. Other prices collected from markets include input prices at sale points; livestock prices (sheep, goats, poultry, pigs); and transport charges (from source to destination charges). The methodological approaches adopted include silent observation, direct enquiries from sellers and enquiries based on purchases by buyers. Data is collected in the markets between midday and 2pm when trading is very active. Based on the protocol for market

surveys, the prices observed or collected per unit weight are averaged. Currently, the average prices are computed from 3 to 5 survey respondents. The small sample size limits the robustness of 'average' prices computed and reported. In the absence of large sample for meaningful statistical computation of average and associated measures of dispersion, it is better to report the most quoted price per unit weight. If there is a desire to maintain the computation of average or mean prices, then relevant measures of dispersion must also be presented.

An important methodological concern is the sample size, fixed by SRID at between 3 and 5 survey respondents (mainly sellers and occasionally buyers) in each of the 178 markets irrespective of the size of the sampling frame for any crop or livestock. It is possible that some markets may be so small that there may not be enough participants. This should not limit statistically robust approach to sampling of respondents at farm gate, market shed, and town/district markets. If resources (in terms of time, personnel and cost) are limiting, then the remedy might be to reduce the survey of 178 markets to more manageable number of markets for which statistically robust approaches will be used to sample respondents and obtain prices with 99% or at least 95% confidence. In some cases, (e.g. determination of farm gate prices) multiple sources of information and calculation are used. Methodologically, this is a sound practice if there is triangulation of data from the different sources.

At least two other institutions (GSS and Esoko) regularly collect retail price data on foodstuffs from selected markets. There is an opportunity for SRID to review its market data collection strategy and seek to triangulate its data with data from these two sources. For example, Esoko (a private entity) regularly reports (through TV3 and other outlets) market prices for foodstuffs. GSS also prefers to use its staff, based at regional capitals, to routinely collect retail prices on foodstuff used for the calculation of the CPI (Consumer Price Index). There are opportunities for SRID to collaborate with GSS and Esoko on methodologies for the collection of retail food prices. The division of tasks will help to avoid duplication or triangulation of data where at least two institutions collect retail data from the same markets. However, SRID needs to check carefully the methodologies used by other institutions to collect the retail price data.

GSS depends on SRID for farm gate prices used for calculating GDP. SRID has a simple formula which can be adapted in a 'value chain approach' to calculate farm gate prices where they are not observed. Methodologically, SRID should identify the chain of linked markets from the farm gate to village collection and assembly points or market shed, to urban wholesale assembly points to city wholesalers and retailers who market to consumers. Taking yam as an example, SRID would trace actual wholesale and retail prices and associated service fees from farm gate sales to traders from Techiman or Salaga who gather/collect yams from farms for sale to wholesalers at Techiman or Salaga. It then traces sales to wholesale buyers from Accra who purchase yams from Techiman or Salaga for sale at wholesale prices to traders at specific Accra markets such as Agbogbloshie or Mallam Atta Market. These traders then sell to retailers at Agbogbloshie Market or Mallam Atta Market, who also re-sell to final buyers/consumers. When prices and service fees along the 'chain' of markets are well researched and established, it will facilitate the calculation of farm gate prices when they are not observed by the enumerators (since farmers typically sell to meet cash needs and would not wait for an enumerator before deciding to proceed with sales). In addition, analysis of the contributions of various factors to price margins noted along the market 'chain' would provide useful information to business and policy decision-makers. So, it is not enough for SRID to stop at reporting wholesale and retail prices to "customers" or "stakeholders".

3.0 Analyses & Reporting of Statistics

The key principles that should guide SRID investment of human and financial resources in data collection include:

- The use or value of the data for policy and business decisions;
- SRID's comparative advantage in the collection of specific types of data;
- Non-duplication of data collection activities by different agencies at the same level on the same products or items and;
- Prompt analyses and reporting of statistics on agricultural sector data to inform business and policy decisions.

In this regard, the analyses and reporting of accurate informative statistics are of extreme importance. Based on reviewed data analyses and statistics reported by SRID, some improvements are needed. Where necessary, SRID should invest in software and capacity building to facilitate informative analyses and reporting of robust statistics, desired or demanded by stakeholders including policy and business decision makers. The specifics are noted in the sub-sections below.

3.1Primary Data

3.1.1 Production Statistics

Where SRID desires to report "average" or "mean", the data reported should go beyond simple mean or average to include measures of dispersion (standard deviation, ranges-max and min, and sample size).

In Table 4.4 (with reference to Agriculture in Ghana: Facts and Figures 2014), the reporting of milled rice and paddy rice is superfluous since a milling conversion rate is used to convert rice paddy to milled rice. A more useful rice classification, for business and policy decisions, would be to distinguish between brown, aromatic and non-aromatic rice production.

The explanations on "achievable yield" and "achieved" in Table 4.7 (Agriculture in Ghana: Facts and Figures 2013) as well as "potential" yields in Table 4.7 (Agriculture in Ghana: Facts and Figures 2014), require a lot more clarity. Both "Achievable yield" and "potential" yield should be replaced with yield on researcher-managed plots (stating clearly whether the plots were on-farm or on-station). Also, it is important for SRID to remember that more effective extension and use of recommended technologies may not be the whole reason for the differences. The management of the fields and timeliness of farm activities are important factors.

Data and other information in Table 4.8 (Agriculture in Ghana: Facts and Figures 2013; Agriculture in Ghana: Facts and Figures 2014) should be reviewed. In the absence of actual surveys to estimate per capita consumption, the use of food availability data requires that the heading be properly renamed as "Per Capita Food Availability from Food Stocks" (production plus imports). "Apparent" per capita consumption labeling in the 2014 publication does not resolve fundamental flaw in the caption of Table 4.8. Food availability is not the same as food access and consumption, particularly in developing countries such as Ghana. It is important to note that due to losses (to pests, damage etc.) in storage, the total food stocks need to be adjusted by typical percentage losses in storage.

During the validation workshop, GSS informed the workshop that its national database on household expenditures include data that can be extracted to produce food consumption per capita. The methodology used to obtain the data involved "embedding" enumerators in households to record daily food consumption and expenditures by all household members. SRID should extract relevant food consumption per capita from the national consumption and expenditure database held by GSS.

It is advised that SRID should make additional efforts to separate some commodities into identifiable and price differentiating categories. This would be important for business and policy decisions. For example, rice should be split into aromatic and non-aromatic. Also, sorghum should be split into red and white types, and yam data should be split into two varietal groups that have different prices such as the high

priced "poona" or "labreko, and the low priced white yam. The use of the low price for white yam for valuation invariably leads to the underestimation of the total value of yam production in Ghana. This negatively impacts the GDP calculation.

Also, SRID should make efforts to explain the reasons for the observed annual differentials noticed in the production data (whether in graphics or in tables). What key lessons could be teased out of observed price trends?

GSS is keenly seeking data on the area covered by other crops, outside the 11 crops surveyed by SRID, and the production levels. The data are required by GSS to properly capture agriculture's contribution to GDP. It is recommended that SRID works with GSS to undertake a baseline data collection on all crops, possibly as part of the GSS national coverage of data collection on household expenditures.

3.1.2 Marketing statistics

SRID distributes raw wholesale and retail prices to persons and institutions in its "list serve". SRID is encouraged to move beyond the reporting of weekly or monthly average prices to include the reporting of more robust statistics on price trends (seasonal and annual). This is an activity that SRID may want to undertake in collaboration with GSS and teaching and research departments of public universities.

3.2 Secondary Sources: Data and Statistics

SRID reports secondary data that it obtains from other directorates within MoFA and from institutions outside MoFA (e.g. GSS, GEPA). However, not all data are transmitted directly from the directorates to SRID. Since the creation of SRID and the Monitoring and Evaluation Directorate out of the defunct PPMED, PPRSD for example sends its data to the Monitoring and Evaluation Directorate of MoFA and not to SRID. It is possible that this practice is not unique to PPRSD. While there may be legitimate reasons for the data to be sent to the Monitoring and Evaluation Directorate, it is also essential for the same data to be transmitted to SRID in its capacity as the central statistics directorate of MoFA.

Additionally, the methodologies used by all secondary sources, within and outside MoFA, should be properly understood and evaluated by SRID for data accuracy. Not all the relevant details and methodologies currently used to collect and cross-check data collected are documented for easy verification and quality assessment.

The senior management of MoFA should put in place formal institutional arrangements which ensure that, at least for the sake of building institutional memory, all Directorates document data and methodologies used to collect them. Copies of final corrected dataset, and the methods used to collect them should be made available to SRID by all MoFA Directorates at specified times (e.g. quarterly, bi-annually or annually).

3.2.1Imports Data

PPRSD outlined a well-documented fertilizer registration procedure for importers and a list of approved fertilizers for agricultural use. Before an importer is registered, samples of the products to be imported are taken through bio-efficacy trials in the field to assess conformity with expected qualities of the contents and phytotoxicity to plants. These trials are conducted by the University of Ghana, Kwame Nkrumah University of Science and Technology (KNUST), Soil Research Institute, and Savanna Agricultural Research Institute (SARI). Presently, PPRSD uses the agricultural fertilizer import permit process as a source of data on fertilizer imports.

Despite PPRSD confidence that the import permit process would lead to a reasonable accuracy in data, it is still possible that there could be discrepancies between data from import permit applications and actual landed quantities of fertilizer imports. Per PPRSD, although every importing company is expected to

provide to PPRSD quarterly data on actual fertilizer imported, stocks and disposal, PPRSD confirmed challenges in obtaining the requisite data from the importing companies. To remedy the challenges, PPRSD plans to use the waiver application to seek data on quantities imported. However, there are additional sources of secondary data (e.g. GSA). PPRSD and SRID should consider accessing relevant agricultural fertilizer imports data from such sources periodically for triangulation. CSD made available detailed data on fertilizers imported, as obtained from GCNet sources.

However, occasional errors in data from GCNet and it common codification system have been noted and corrected. The methodology used is to classify and separate fertilizers imported by mining companies from the total fertilizer imports. Therefore, the methodology here focuses on the identification and business orientation of the importer (mining, or agriculture) for some types of fertilizers used by both the mining and agriculture sectors. Furthermore, there is an inter-agency group (comprising GSS, SRID, CSD, PPRSD, GSA, and IFDC), which meet periodically to review data on fertilizer imports. This inter-agency consultation to review data is a useful model for checking for the robustness of data on other agricultural imports. It is recommended that SRID takes a cue from the operation of this inter-agency review group for fertilizer and explore with GSS how similar periodic data reviews can be organized for other agricultural imports with major stakeholders (importers and permit granter).

Within MoFA, the procedures for cross-checking and validating agricultural fertilizer imports data include an initial meeting between PPRSD, SRID, Customs and Excise, and GSS. This meeting is followed by another workshop during the second week of January each year.

PPRSD also supervises the importation of seeds. Imports data captured at PPRSD headquarters include the weight of goods to be imported and the number of applicant importers per crop. Before import permit is issued, data are collected on the importer and dealers who will sell the goods and the farmers targeted for distribution. At the port of entry (seaports and airport), phytosanitary officers from PPRSD check the quantities and other details on the invoice covering the imported commodity and then proceed with sampling for testing in the laboratory.

For all plants, plant products and regulated articles, the importer applies to the Minister for a permit. Invoice is attached to the permit application to indicate the source of the commodity. PPRSD checks, from internet sources, on pests associated with the commodity in the country of origin, and pests that attack the commodity in other countries. PPRSD conducts pest risk analysis to determine if the imported commodity will not pose any phytosanitary risk. When this is clear, then an import permit (requirements including conditions for importation and export phytosanitary permit from the exporting country) is issued. When commodity arrives at a port of entry, quantity imported data is reconciled between imported quantities and data on the phytosanitary certificate from the exporting country.

Prior to 2015, data captured by PPRSD in its annual reports are the bulked plant product imports. Since 2015, a new format has been instituted to capture disaggregated data on individual imports every day at the entry points. PPRSD must seek the necessary funds and invest in software and computerized systems to facilitate data capturing at all the active entry/exit points, and transmit the data electronically in real time to PPRSD head office for verification.

GSS also noted occasional problems with import data recorded in the GCNet database. It noted the existence of disparities in the data on imports supplied to GSS, Ministry of Trade and the Bank of Ghana. GSS noted that the inconsistencies and lack of accuracy of data from GCNet sources were because not all data pass through GCNet. There is a strong case for inter-agency coordination to facilitate periodic comparisons or triangulation of imports data recorded at GSA, GPHA, PPRSD, GCNet and Ministry of Trade. Such coordination, led by GSS and SRID (for agriculture items), could include representatives of

other major stakeholders in data collection and documentation (e.g. VSD, CSD and PPRSD from MoFA, Customs division of Ghana Revenue Authority and GSA).

Veterinary Services Directorate (VSD) personnel are stationed at formal border entry points. They issue livestock movement permits after inspecting and certifying that the animals and animals' products inspected are free from animal diseases. The livestock inspection data captured are transferred onto Veterinary Form 14 (Annex C1) and reported monthly. The annual data on livestock imports are in Annex C2. However, the accuracy of VSD data collection is challenged by the numerous informal or unapproved land border entry points where VSD personnel are not stationed. This results in animals (particularly small ruminants carried on motorbikes and cattle walking across unapproved routes) entering the country without the proper certification (inspection) and therefore not captured in the data base on livestock movements. At the air and sea ports, VSD staff deal with documentation presented by prospective clients. However, VSD personnel do not have access to the manifests of vessels or aircrafts that bring in the animal products and therefore it is not certain that all imported livestock are captured in database.

Animal Production Directorate (APD) documents feed imports (ingredient for animal feed – concentrates, pre-mix, fish meal). Waiver mechanism is the main way of checking quantities imported. APD ports officers verify import data at the port of entry (Tema). They cross-check data on waiver application with data from bill of laden, and commercial invoice. APD has online access to bill of laden data, commercial imports data and certification of analyses of feed inputs, through GCNET. However, APD is yet to capture additional data from farm feed mills or feed compounded by dispersed farmers on their farms to feed livestock. Additional sources of data for triangulation include Ghana feed miller's association, poultry farmer's association, pig farmers, Ghana cooperative butchers and livestock owner's association with membership of over 30,000 throughout the country.

Ghana Shippers' Authority (GSA), which is the umbrella body representing importers and exporters, documents seaborne shipments (imports of bulk and bagged grains, fertilizer and sugar) at Takoradi and Tema ports. The data are not disaggregated well enough in the case of fertilizers. Similarly, the Ghana Ports and Harbour Authority (GPHA) explained that data captured in their records are not disaggregated well enough and some items in containers are not checked since the containers are not opened.

3.2.2 Exports data

Ghana Exports Promotion Authority (GEPA) collects data on exports of non-traditional agricultural food crops and products. However, GEPA's primary source of export data is the GCNet database. GEPA carefully reviews data from the GCNet sources and adjusts the data, after conducting checks with relevant importers.

At PPRSD, all exporters of plants and plant products are registered at the headquarters and at the regional offices. The exporters, together with the related/linked growers (particularly the fruits and vegetables) are assigned codes. Waybills signed by farmers, together with summary packing list from the exporter, are submitted to PPRSD inspector at the ports for documentary checks. Samples are taken from materials for export in the holding area for plant health inspection (phytosanitary inspection and certification). If the consignment meets the import requirements of the importing country, then the phytosanitary certificate is issued. The consignment is protected till scanning. Custom officials collect the scanned quantities irrespective of their contents. Therefore, customs data would not match data from PPRSD for triangulation. Moreover, the quantities declared at the point of exit should tally the data to the importing country otherwise the consignment will be detained at the point of entry of the importing country. Exports data are collected at all active entry/exit points (airport-KIA, seaports, and the relevant postal offices) were Customs and Excise Division of the Ghana Revenue Authority and PPRSD staff are posted.

3.3 Other Local Secondary Data

GSS has 10 regional statistical offices, from where GSS personnel go to markets to collect primary retail data directly. The data are used for calculating the CPI (Consumer Price Index). There is likelihood of duplication in the collection of primary retail market price data by GSS and SRID's marketing services department. This is because GSS was unaware of the retail price collection activity by SRID. Synchronization of market retail price data collection and methodologies between GSS and SRID would save financial and human resources, and ensure that the two statistical units work in synergy.

GSS depends on the receipt of farm gate prices from SRID for the calculation of GDP (Gross Domestic Product). Since GDP is value-based, disaggregated data on both production levels and prices are extremely important. A GSS representative gave an example of fish valuation by species which created an issue about fisheries growth rates. A negative growth rate was recorded because although the total fish catch reported had increased in that year, as compared to the reference year, a greater proportion of the catch in the reference year comprised of higher value tuna while the second year had large amounts of lower value 'kpanlaa' species leading to the recording of lower total value of production. In this case, the species-level data disaggregation made it possible for the detection of the reasons for the negative growth rate despite the reported higher total fish catch.

3.4 Sustainable Value Chains

One of the key requirements of the TORs is for the consultant to "provide new and improved methodologies through desk research and discussions with coordination team for collecting and analyzing data more efficiently and effectively in Ghana on value chain basis sustainably and use two case studies to substantiate the recommended new methodology." It was not clear what types of value chain analyses are conducted by SRID either routinely or through commissioned studies. Repeated requests to SRID for information remain unanswered. However, as per the requirements of the TOR, desk research was conducted on sustainable value chains and illustrative data from Ghana were sought and used as two examples in a case study. Appendix 5 presents the VC methodology for the analyses of sustainable food VC, with application to two illustrative examples for rice and oil palm VCs.

3.5. Institutional Issues on Data Collection and Sharing

The lack of reliable data on the horticultural crops sector was highlighted during the restitution workshop. There is an urgent need to pay attention to the data collection on the emerging and developing horticulture sector. GSS also bemoaned the limited coverage of SRID data collection and documentation activities. Indeed, the current limited coverage of 11 food crops makes it difficult to truly capture the contribution of agriculture to GDP. The GSS informed the restitution workshop about funds it had obtained to conduct baseline survey on the agricultural sector. It is important for SRID, and indeed all directorates of MoFA, to be involved in the design of the planned survey to ensure that essential baseline data are properly captured during the survey.

In the preceding sections of this report, institutional issues surrounding data collection and dissemination by directorates within MoFA, as well as potential risks associated with the lack of direct data collection supervision by SRID have been highlighted. It is important that the management of MOFA at the senior level, puts in place an organizational mechanism that mandates the submission and the delivery of data collected by other directorates to SRID. The direct supervision by SRID of District Departments of Agriculture that collect data in the field, is essential. There is a distinct advantage in allowing SRID to train field staff in methodologies and ensure that the staff collect robust data.

4.0 Concluding Comments on Recommendations and Implementation Strategies

Data collected by SRID is very important for policy and business decisions. The CPI and GDP are examples of relevant economy-wide indices requiring data documented by SRID. However, there is the need to

ensure a high level of accuracy and robustness of data. This requires the use of sound methodological approaches and systematic accuracy checks based on triangulation of data from different sources.

To address the data collection, presentation, and methodological shortcomings identified at SRID, recommended remedial actions and implementation schedule are presented as recommended next steps in Appendix 6. The methodological processes and strategies for effecting the remedial actions proposed are in the case studies (appendices 1-5). Specific changes recommended include:

- The allocation of land area to component crops in mixtures/intercrops;
- Yield estimation that captures heterogeneity on farms;
- The need to move away from the use of only 3-5 sample respondents per enumeration zone to the use of statistically sound measures such as the Slovin's formula to calculate sample EAs in each district and sample farmers mapped in the sampled EAs during annual surveys conducted by SRID;
- A change from reporting "average" or "mean" based on small number of respondents;
- The need to report measures of dispersion alongside any report "average" and;
- A change from reliance on oil palm production data from few major estates to the use of field-level measurements to obtain oil palm production data, particularly from individual plantations.

In the case of secondary data, the recommended strategy is to institute well-structured periodic engagements with GSS and other institutions working on agricultural data to collectively review data collection methodologies, types of data and perform accuracy checks. This will also facilitate the triangulation of data held by various agencies. Existing periodic consultations and review processes on fertilizer imports data provide a useful model.

It is essential to build the capacity of SRID staff for statistical analyses, especially in the use of modern equipment and software. The aim would be to facilitate accurate data capture, measurement, recording and transmission to a central database. To enhance the capacity of SRID, it is recommended that SRID, through MoFA, links up with relevant academic departments and research institutes in tertiary institutions to undertake joint analyses and publication of agricultural statistics.

Finally, it is recommended that senior management at MoFA sets up and institutionalizes a mechanism for cooperation among all its directorates in the sharing of data and methodologies. A specific timeline (e.g. quarterly or bi-annually) should be set for all directorates to send copies of data, and methodologies used to collect them, to SRID. Also, it is recommended that duplicates of all the agricultural data and protocols showing methodologies used to collect the data be stored off-site (from SRID).

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Table 1: Workplan for Implementing the Consultancy Activities, 2016

	April	May					June			
Activities	Wk 4	Wk 1	Wk 2	Wk 3	Wk 4	May 30	Wk 1	Wk 2	Wk 3	Wk 4
A. Inception meetings B. Desk Research	X X	X	X	X	X	X		X	X	
C. Visits Sources of Secondary data and Primary data collection.		X	X X	X X						
D. Draft consultancy reports & discussions of options with SRID staff.	X			X	X			X	X	
E. Workshop to present report, feedback and finalization of Consultancy report.										X

Table 2: Data Generated by Institutions and by Source

Institution	Data generated	Source of data
Statistics Research and Information Directorate	• Crop area, yield and production • Agricultural Input prices • Market price information for agricultural commodities • Agricultural Census • Early Warning and Crop Forecasting • Transport Cost • Farm gate prices of food commodities	• Survey • Survey • Survey • Survey • Survey • Survey • Survey
Policy Planning Monitoring and Evaluation	• Monitoring and evaluation	• Survey
Crop Services Directorate (MOFA)	• Planting materials and seed input production and distribution • Monitoring of fertilizer imports • On-farm trials/demonstrations	• Administrative records • Administrative records • Survey
Veterinary Services Directorate	• Livestock census and production estimates • Livestock Input and veterinary activities • Livestock trade	• Survey • Administrative records • Administrative records
Ghana Meteorological Agency	• Agro meteorological data	• Administrative records
Ghana Cocoa Board	• Cocoa production, revenue	• Administrative records
Ghana Statistical Service	• National Accounts • Household Survey • Population Census • Employment and Labour force • Consumer prices • Import and export of Agricultural commodities	• Administrative records • Survey • Survey • Survey • Survey • Survey
Ministry of Trade and Industry	• External Trade Statistics	• Administrative records
Ghana Export Promotion Agency	• Volume and value of Non-traditional Agricultural exports	• Administrative records
Bank of Ghana	• Trends in interest rates, foreign exchange, domestic credit	• Administrative records
Agricultural Development Bank	• Credit facilities to farmers	• Administrative records

Compiled and supplied by SRID.

Appendix 1: Case study 1: Example of statistically sound methodology for calculating sample size, from the mapped population of farmers for each crop in a district

Background

A general methodological approach to improve robustness and data accuracy is to use scientific measures to determine the sample size from the mapping/listing of farmers for each crop and livestock category. According to SRID, 5 respondent farmers are selected in each of the 40 enumeration areas and these data are used for estimating crop production. Also, only 3-5 traders are surveyed in markets for market studies. From these samples, average or mean statistics are calculated, with no additional data on measures of dispersion around the average or mean. Good sampling is an important pillar for robust data. Therefore, SRID may want to explore the use of statistically-sound sampling techniques in generating primary data.

Objective

Provide an example of a scientifically robust method of estimation of the number of sample farmers, from mapped population in a district for each specific crop.

Methodology

There are a number of online tools for calculating sample size. The National Statistical Service of Australia provides a kit and this is available at the link below:

[http://www.nss.gov.au/nss/home.nsf/pages/Sample+size+calculator].

Usually, where the characteristics of a population are well known, prior information facilitates the determination of a sample size. In many cases, where the distribution of key population characteristics is not known, Slovin's formula [$n = N / (as\ 1 + Ne^2)$ where n = number of samples, N = Total population and e = Error tolerance desired] is used to calculate the sample size. Assuming the total number of maize farmers listed or mapped in a district is 5000, and taking 95% as the acceptable confidence level (implying the desired margin of error of 0.05); using the Slovin formula:

$n = N / (1 + N e^2) = 5000 / (1 + 5000 * 0.05^2) = 5000/1+5000*.0025 = 5000/13.5 = 370$ farmers.

It is worth noting that, statistically it is best to limit the choice of margin of error to either 0.01 or 0.05 to give high level of confidence to the sampling. The sample farmers can then be selected either purposively (where marked differences exist between farmers) or randomly (where uniformity is dominant), across the district.

Discussion and Recommendations

To enhance robustness of primary data collected, SRID should follow a statistically acceptable methodology for determining adequate sample size with 99% or at worst 95% confidence. Slovin's formula has been used in this case study to illustrate how SRID can proceed.

Appendix 2: Case Study 2 - Estimation of land cultivated to component crops in intercrops or mixtures.

Background

Many cultivated farms in Ghana contain mixtures of two or three main crops. On some farms, the mixtures would contain component crops that are part of relay-cropping or crop rotation. Allocation of land area to each of the component crops in relay cropping or rotation is the same as for sole cropping if the same cropping densities are used. However, some of the mixtures are also intercrops where the component crops are grown at densities lower than what occur under sole cropping. Estimating land area for each of the crops in an intercrop is not as straightforward as measuring land area occupied by sole crop. Allocation of the same measured farm size to each of the component crops in intercrops would lead to over-estimation of land occupied by each component crop in intercrops and the total land cultivated to all crops. A change in methodology is required to produce more accurate and robust estimates of land areas occupied by component crops in intercrops.

Objective

Use this case study to illustrate a more robust estimation of cultivated land areas for crops in mixtures where components are intercropped.

Proposed Methodology

Plant spacing and densities differ in mono-cropping and mixed cropping systems. Therefore, a sound methodology is required to obtain the area under a particular crop in an intercrop or crop mixture. Craig and Atkinson (2013) provide a literature review on crop area estimation methodologies. For intercrops or mixed cropping systems, FAO recommends that the estimated area for each one of the associated crops should be calculated as the area that the particular crop would have covered if it had been grown alone (FAO 1982). Following this methodological approach, the area under cultivation to intercrops is distributed between the component crops in proportion to the area of the land they are cultivated on. In practical terms, the recommended methodological approach would first estimate plant densities for each of the crops in mixed cropping and sole cropping on farms in the same locality. Next, the relative plant densities for each crop, in mixed and sole cropping systems would determine the proportion of land to allocate to each component crop in a mixture or intercrop.

A practical example would explain the methodology. For instance, farmers in the forest and transition zones intercrop maize with cassava. Actual field level planting densities used by farmers differ from recommended practices. Data collected by IITA project on actual planting densities for maize and cassava are as follows:

- 32,610 plants per hectare for sole maize and 31,500 maize plants/hectares in the maize-cassava intercrop; and
- 12,500 cassava plants per hectare in sole cropping and 5,000 cassava plants per hectare in maize-cassava intercrop. (credit Samuel Adjei-Nsiah, IITA project in Ghana)

Using the data on crop densities, instead of allocating 1 hectare each to maize and cassava in the maize-cassava intercrop, (as per current SRID methodology which leads to over-estimation of land cultivated to each crop and to both crops) the proportional allocation of the 1 hectare maize-cassava intercrop is calculated as: 31,500/32,610 *1hectare=0.96 hectare for maize; and 5,000/12,500*1hectare=0.4 hectare.

Discussion and Recommendations

The Land equivalent ratio (LER) of 1.36 (0.96+0.4) means that 36% more land would have been required to grow maize and cassava (found in the intercrops) in pure stands at the stated densities. The LER of 1.36

is comparable with research findings which demonstrated that full-season maize intercropped with short-duration cassava gave LER of 1.5 *(*Ennin et. al., 1999*)*. These findings are consistent with research findings which demonstrated the advantages of intercropping in general (Thayamini et. al., 2010). It would be best for SRID to report much more detailed statistics on land area.

These should include:

- Actual measured farm sizes for sole crops;
- Actual measured farm sizes for major intercrop systems; and
- The calculated LERs for crops involved in intercrops.

Appendix 3: Case Study 3 – Accounting for heterogeneity in the estimation of crop yields on farms.

Background

SRID relies on sample field measurements to estimate crop yields. One yield plot (differing in size for different crops) is marked out per farm for crop yield estimation as outlined in the GAPS (Ghana Agricultural Production Survey) fieldwork manual, (SRID/MoFA, 2011). To minimize human-biases in the choice of yield plots, equipment-assisted random field selection procedures are followed. However, the single yield plot per farm is unlikely to properly account for yield differentials due to heterogeneity (in terms of resource potentials or management) on farms. For example, the yield estimation methodology used by SRID does not distinguish between high potential fields or fertilized fields as compared to marginal/low potential fields and non-fertilized fields within the same farm. The yields, irrespective of land quality and management as well as heterogeneity on farms, are simply averaged for each crop. This raises a challenge in terms of accuracy of yields. In addition, random selection of starting point for yield plots assumes uniformity of land and management within the same farm.

Estimating crop yield by sampling a small subplot within cultivated field was developed in the 1950s in India (Fermont and Benson, 2011). Brydon and Rennie (1990) report that yields estimated along transects gave better estimates (accuracy of within 10% of the true mean grain yield at 90% probability) than grouped mean data.

Objective

Use a case study to illustrate more robust yield estimation on farms to account for heterogeneity.

Field Assessment of maize yields on-farm

To improve representativeness of yield estimates from a farm, we propose a different approach. First, the farmer and enumerator should take walks across transects on selected farms to note marked differentials in natural resources or management on the farms which would influence yields. On each farm, they should use purposive sampling of 5m x 5m plots to reflect observed marked differences where there is evidence that such marked differences in natural resources or management are likely to influence crop yields. For farmers' fields, which are uniform, a sample size of 10 m by 10 m plot per farm for grain yield assessment could be used but for large fields which are not uniform, sampling can be done on three replicate plots, each measuring 5m by 5m and the average used (Credit: Samuel Adjei-Nsiah, IITA project in Ghana). The yield plots are best harvested just before the farmer harvests the crop for storage, noting the moisture content of the harvested product (Casley and Kumar, 1988). Note that:

- After harvest, the cobs should be de-husked;
- The cobs should then be weighed and the weight recorded;
- Ten cobs should randomly be picked and weighed and;
- The shelled dry weight should be used to compute dry matter (DM) yield of the grains per hectare.

The grain yield can then be expressed either at 12% moisture content or 15% moisture content which is the moisture content at which commercial grains are sold. For example, maize cob yield from a plot size of 5m by 5m weighs 20 kg. 10 cobs randomly selected weighed 2kg. After drying and shelling the 10 cobs, the weight comes to 0.750 kg. Therefore, dry weight of the 5m by 5m plot is computed as: (0.750/2) *20 kg =7.5 kg. When 7.5kg is converted to yield/ha, it becomes: (7.5*10,000 m^2)/25m^2 = 3000kg/ha. At 15% moisture content, the yield becomes (3000/ (100-15) = (3000kg/85) *100= 3529 kg/ha.

Discussion and Recommendations

The proposed methodological approaches will provide greater accuracy in yield estimation (purposive sampling is to reflect heterogeneity on farms). An alternative is to locate yield plots across transects which capture heterogeneity on farms.

To obtain the total farm harvest, it is best to multiply the number of sample plots on land with the same potential or management, by the corresponding average weight. We recommend pilot comparison between data from current methods used by SRID and estimating yields from plots purposively identified, selected or marked out at specific intervals/distance along a transect of the farm. For crops grown across different ecological zones, it is recommended that SRID reports yields (averages and associated measures of dispersion) on ecological zone basis.

Appendix 4: Case study 4 – Methodologies for the estimation of yields and land area under cultivation of oil palm.

Background

In the 2013 facts and figures on agriculture in Ghana, SRID reported aggregation of only area, yield and production of major companies involved in oil palm cultivation. This restriction underestimates the real data. Upon enquiry, it was observed that SRID had not sought advice on area and yield estimation methodologies from relevant national scientific research institutions. This case study presents advice from the Oil Palm Research Institute (OPRI) of the Council for Scientific and Industrial Research (CSIR) on both the oil palm yield and area estimation methodologies.

Objective

Provide SRID with scientifically sound methodologies for carrying out the estimation of yield and area under cultivation to oil palm.

Proposed methodologies

A) Oil palm yield:

- Individual Fresh Fruit Bunches (FFB) should be weighed and recorded immediately after harvesting.
- The mean weight must be calculated.
- Record the number of bunches harvested from trees.
- The mean number of bunches per tree should be calculated.

Finally, to obtain the yield apply the formula: Oil palm yield (Tons per ha) = mean no. of bunches x mean total bunch weight x 148 (standard no. of trees per ha)/1000*
(*note that without dividing by 1000, yield records will be in Kg per ha)

B) Oil palm area estimation:

- Use GPS navigation device.
- If the plantation has been established based on the standard planting distance of 29 feet triangular, then the number of plant stand of 60 is treated as 1 acre or 0.4 ha.

Discussion and Recommendations

There is a substantial number of individual investment in oil palm production. Some of the producers may be out-growers for the major companies but there are other producers who are not in out-grower schemes and do market or process oil palm fruits produced. The yield and area estimation methodologies described in this case study would help SRID to proceed with improving statistics on oil palm by capturing additional data, hitherto neglected, from individual holdings. It is recommended that SRID adopts the methodologies described in this case study to better capture data on oil palm.

Appendix 5: Methodological approach to analyze crops for sustainable food value chains, using rice and oil palm as illustrative case studies.

Introduction

The TOR for the consultancy includes a request for two case studies on sustainable value chains. Value chain (VC) analysis focuses on identifying and studying the successive actors or firms and their activities from the inputs to production of raw product to processing for value addition till a final product reaches the final consumer. In business circles, VC is studied to expose strategic and operational misalignments in the firms in a chain, to identify misallocation of resources and opportunities for improvements that create value and economic sustainability (Fearne et al., 2012).

The concept of sustainability has inter-generational aim of ensuring that benefits accrue by firms and society from current production activities would not be at the expense of the capacity of future generations to benefit from productive activities that are based on the use of the productive assets. Therefore, complete sustainable food value chain analyses should incorporate dimensions such as profitability to firm and society, social impacts (e.g. reduction in poverty or food security) and environmental effects or consequences. These concepts underpin David Neven's (2004) definition of sustainable food value chain as "the full range of farms and firms and their successive coordinated value adding activities that produce raw agricultural materials and transform them into food products that are sold to final consumers and disposal after use, in a manner that is profitable throughout, has broad-based benefits for society and does not permanently deplete natural resources." For agriculture, the key naturally-occurring productive assets or natural resources are land, water and trees.

A methodology for undertaking sustainable value chain analyses is outlined below. It attempts to help practitioners to identify the specific points for data collection and the types of data which would be of interest in determining profitability to each active firm and society, environmental and societal dimensions of all productive activities along a value chain.

Proposed Methodology

- Define and map (literally draw a map) all the farms/firms that are successively involved in profitable endeavors that lead to the production of a final product for the consumer.
- For each farm/firm identified and mapped, describe the type of production activity, collect data on quantities (inputs and outputs), costs (inputs) and prices (of outputs). These are required for calculating profit or net return of a firm/farm at each successive level in the value chain.
- At each level along the value chain, also collect data on quantities of byproducts (to be used by other firms or for disposal). Method and the cost of disposals of byproducts should be documented. Where the disposed item is of no known value, find shadow prices or cost to the environment or society.
- For each firm/farm, also list all intermediate products that can become inputs for successive firm/farm in the value chain. Then collect data on the quantities of the intermediate products and their prices/value.
- Determine the net return to firm/farm at each level of the value chain. At the farm level, list the type of production activity which has incidence on the natural resource base (e.g. no till, ploughing, spraying of insecticides, and application of inorganic fertilizers), and then list all inputs used, input suppliers/dealers.
- For value addition firms (processing firms and their range of input suppliers), map all inputs to and products from value addition or processing (main product, by-products or waste products), and note final product storage, haulage and transport firms (e.g. wholesaler traders and transporters). Also, note firms involved in the distribution or disposal of final product to consumers (retailers at markets or sale points).

- It is important to define and map all by-products or waste items for disposal along the successive chain of production activities from farm up to final product. There would be the need to identify benefits and costs to farmer or firm from the disposal of each by-product or waste product.
- It is also necessary to identify and document specific quantities and value and non-valued effects of each by-product or waste product on the environment or on natural resource base (particularly water, land and wood or source of energy).
- Then, assess how productive resources (particularly water, wood or other sources of energy and land used for production) are affected by the disposal of successive intermediate and then the final products.
- Also, assess how productive resources (particularly water, wood or other sources of energy and land used for production) are affected by the disposal of successive intermediate and then the final products.

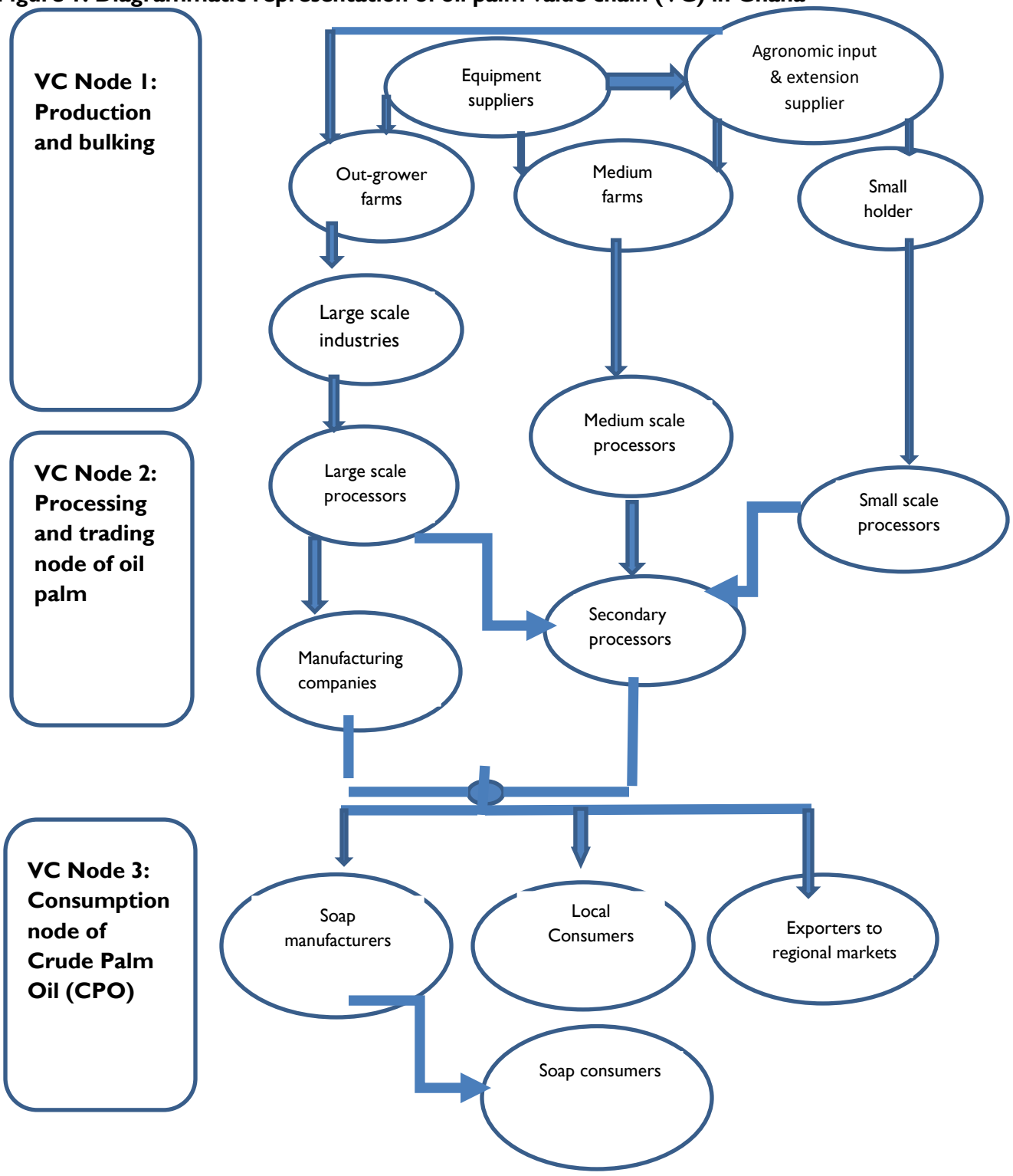
Illustrative case study for the application of sustainable value chain analysis to oil palm

Figure 1 below depicts a graphical representation of the oil palm value chain (an adaptation of the oil palm value chain in Ghana documented by Adjei-Nsiah et al., 2012). There are three key nodes namely:

- the production and bulking node
- the processing and trading node, and;
- the consumption or consumer node for crude palm oil.

At each value chain node, the key productive firms in the oil palm sector in Ghana have been identified. For each firm, the production process should be described. Also, quantities and prices or cost of inputs and outputs (finished and intermediate) should be documented. Profitability to the firm is calculated. In addition, the wastes or by-products and how they are disposed should be documented.

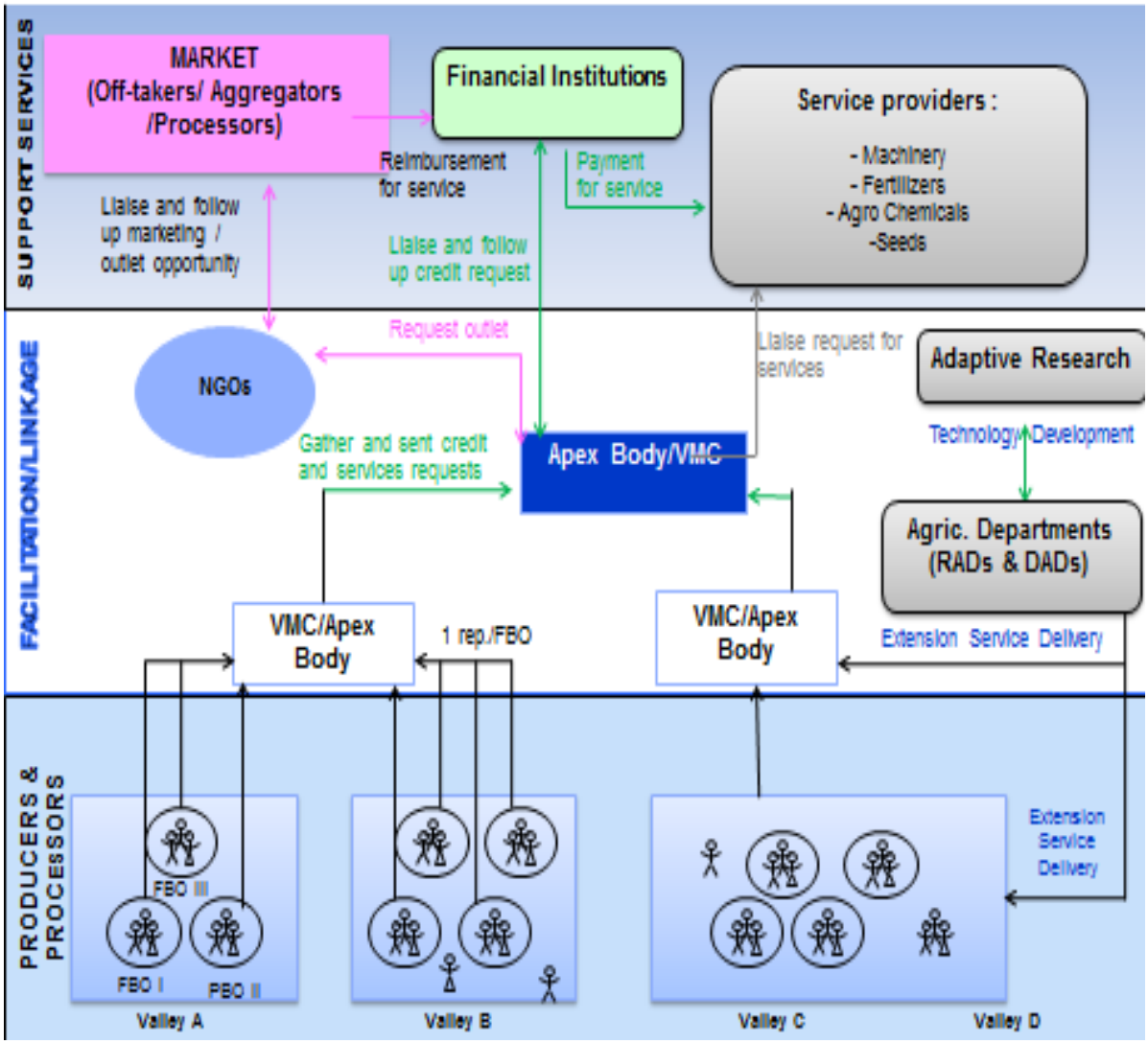
Figure 1: Diagrammatic representation of oil palm value chain (VC) in Ghana



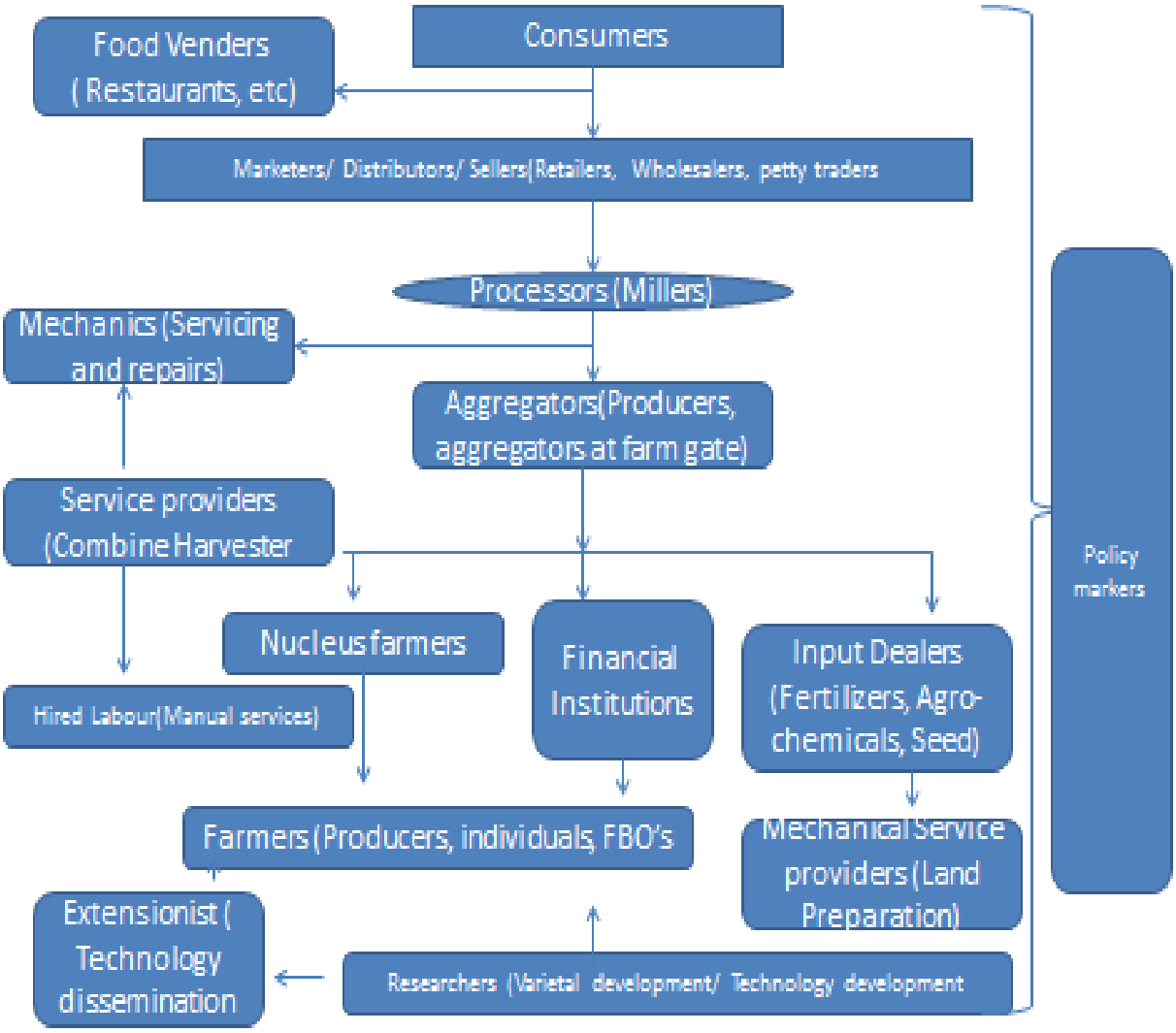
Illustrative case study for the application of sustainable value chain analysis to rice

Figure 2: Schematic diagrams for rice value chain for inland rice project in Northern Ghana.

(a)

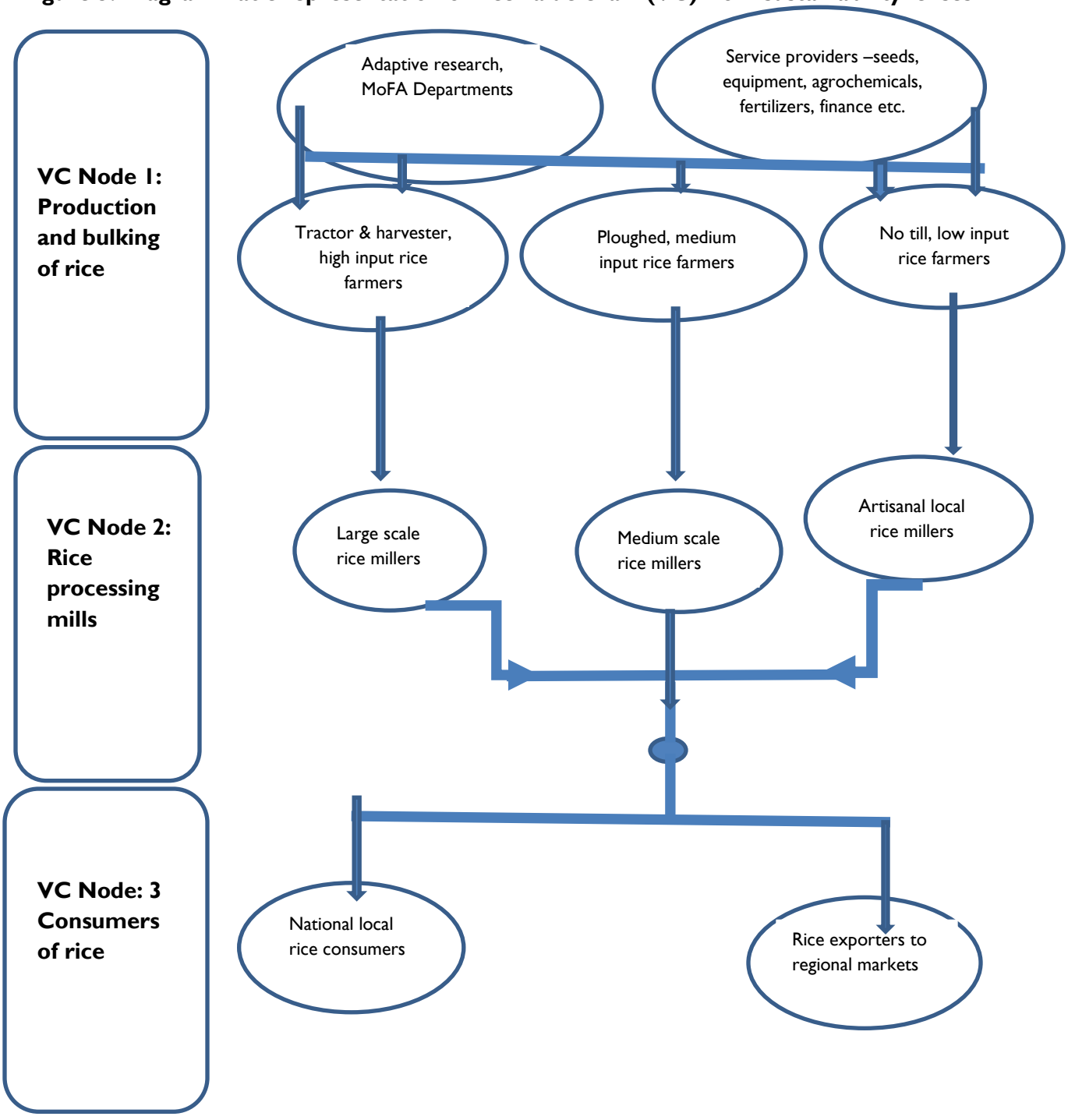


(b)



Source: Richard Twumasi-Ankrah, Inland Valley Rice Project, Tamale.

Figure 3: Diagrammatic representation of rice value chain (VC) from sustainability lenses



Discussion and Recommendations

Figure 1 depicts the oil palm value chain along which actors, their activities and the effects on society and environment, at successive nodes, can be identified, measured where possible, and documented in respect to effects on the environment and society. Research findings show that at least four practices in oil palm value chain are harmful to the environment and the health of people in society.

These, per (Osei-Amponsah et al., 2012) are:

- pollutant smoke from items used by processors as fuel (used car tyres, empty fruit bunches, fibre cakes, bamboo sticks);
- surface water pollution from direct disposal of effluent onto earthen floors at mills or directly into nearby streams;
- processors use for packing containers which contain toxic substances such as cyanide and;
- the use of Sudan dye to adulterate final product for sale to consumers. The Sudan dye has undesirable health consequences for the consuming public.

Figure 2 and Figure 3 show the value chain actors for rice production up to the level of consumers. Parts (a) and (b) of Figure 2 show all the intervening actors and linkage between them in the inland valley rice project in Northern Ghana. Figure 3 depicts a simplified version of the rice value chain from sustainability point of view. At the production stage, the technology and inputs used to produce rice differ from low input (no till, no inorganic fertilizer) to medium input (ploughing, inorganic and organic fertilizers) to high input (machinery, inorganic fertilizers, agrochemicals). Each production technology has implications for soil compaction and health. For example, individuals and the society at large are exposed to health risks where agrochemicals are used to control the African Black Beetle instead of flooding the rice fields.

SRID did not furnish the consultant with methodology followed in any food value chain analyses. Thus, the relative methodological improvements sought by the TOR could not be undertaken. It is also not clear whether data were being (or are to be) collected by SRID annually over time or in commissioned studies.

Measures of sustainability through the impacts on the natural resource base used for agricultural production could be beyond the expertise of SRID. It is recommended that SRID teams up with natural resource economists or environmental economists at the EPA or in research institutions to enhance technical capacity to design studies and undertake data collection for sustainable value chain analyses.

The guidelines on sustainable food value chains by David Neven (2014) provides field practitioners with practicalities involved in integrating the multidimensional concepts of sustainability with added value along a successive production chain. The potential limitations are also discussed. This publication is highly recommended to SRID as a guide to its work on value chains. However, it is important for SRID to pay attention to an important finding by Fearne et al., (2012) which points to limitations of VCA analysis to economic sustainability with inadequate attention to social and environmental consequences of the behavior of firms. Including social and environment assessments in sustainable VCA analysis would avoid risks of rejection by the broader society and lead to environmentally and socially friendly re-allocation of resources along the value chain.

Appendix 6: Summary of the next steps recommended for implementation

a. The generation and presentation of metrics: changes in primary data collection methodologies

	Problem/ issue	SRID practices	Recommended next steps	Advantage(s)	Recommended implementer	Recommended time schedule for implementation
1	How to handle land area allocation to component crops in intercrops.	Total farmland area is allocated to component crops in mixtures.	SRID should distinguish between different types of mixtures namely; relay or rotational cropping, and intercrops. For mixtures comprising component crops planted at sole cropping densities in relay or rotational cropping, the allocation of total farm area to each component crop is correct. However, for mixtures which are intercrops where component crops are planted at densities lower than densities found in sole cropping, SRID should use the proportional crop densities in the intercrops of the sole cropping to determine percentage of total farmland area to allocate to each component crop. In addition to land area, it should report the land equivalent ratio.	Accurate reporting of land area cropped.	SRID	Short-term (within 1-2 years).
2	Crop yield estimation	Yield estimation methods under MRACLS and GAPS do not account for yield differentials due to heterogeneity common on farms.	SRID can apply the selection of single yield plot on farms that have homogenous conditions. However, where heterogeneity affect crop grown and yields on farms, SRID should use transacts across farms, following the observed heterogeneity or it should purposively select small yield plots to reflect yield differentials due to heterogeneity on farms.	More accurate estimation of crop yields on farms.	SRID	Short-term (within 1-2 years)
3	Selection of sample respondents	SRID conducts production surveys using 5 randomly selected respondents in 40 enumeration areas (EAs) per district. The number 40 was chosen to provide enough data points for analyses. This is not a statistically defendable method	SRID should use Slovin's formula at 99% or 95% confidence level to first select sample EAs per district from the GSS EAs per district. Then map the farmers and the crops they grow as the sampling population. When there is lack of knowledge about the underlying characteristics of the population, use Slovin's formula to calculate total farmer sample per district.	More statistically-defendable methodology to select sample EAs and respondent farmers per sampled district.	SRID	Short-term (within 1-2 years).

		in the selection of respondents.				
4	Obtaining farm gate prices for crops.	SRID collects wholesale and retail price data from surveys. It also attempts to collect farm gate prices and costs along the marketing chain.	Where farm gate prices are, observable and collected that is ideal. However, farm gate prices are mostly not observable since farmers dispose their produce on need basis and would not wait for enumerators. Farm level sales recalled would be unreliable. The remedy is to use SRID's own simple marketing formula, linking costs and prices from farm level to the final consumer. This approach will require systematic networking of successive markets/sales points and the actors involved.	Reliable computation of estimated farm gate prices.	SRID	Short-term (within 1-2 years)
5	Data capture at entry and exit points for agricultural imports and exports respectively.	VSD and PPRSD capture data manually from permit application processes.	PPRSD has, since 2015, implemented a disaggregated imports data capture format. This should be effectively deployed at all active entry points for imports. More importantly, PPRSD should seek funds to implement its planned investment in software and computerization to move from manual data capture to electronic data capture and to real time transmission to Headquarters for verification. Also, PPRSD should share with VSD the format developed for data collection at all active entry points. PPRSD should also apply similar format for recording export data at the points of exit/export for agricultural exports.	Real time access to data recorded at entry and exit points. Prompt verification of recorded data by relevant officers at the directorate's headquarters.	PPRSD and VSD Directors	Immediate (within 1 year)

b. The generation and presentation of metrics: presentation of statistics

	Problem/ Issue	SRID practices	Recommended next steps	Advantage(s)	Recommended implementer	Recommended time schedule for implementation
1	Presenting summary statistics on primary data collected by SRID.	"Average" is calculated and presented by SRID without any idea of sample size and measures of dispersion around the mean.	If SRID desires to calculate "average", the sample size and measures dispersion should be presented as well.	More appropriate presentation of summary statistics.	SRID	Immediate (within 1 year).
2	Presentation of oil palm production data.	In SRID's publication on "Agriculture in Ghana: Facts and Figures", oil palm data are from companies operating large estates and some from SRID's estimates of production from individuals.	Use methodologies developed by OPRI-CSIR to calculate area and yields for individual production. Use remote sensing to identify and map area cultivated for oil palm. Then deduct data from companies operating large oil palm estates and their out growers to get a handle on area cultivated by private individuals. This base data coupled with annual sales of seedlings by OPRI are critical for informed projections on oil palm production.	More scientific methodologies for calculating and presenting estimates of national oil palm data.	SRID	Short-term (within 1-2 years).
3	Caption of Table 4.8 in 2014 and 2013 editions of "Agriculture in Ghana: Facts and Figures".	Table 4.8 is wrongly captioned as "Estimated Levels of Per Capita Consumption of Selected Commodities".	The explanatory notes on the table show that the sum of local production and imports divided by the population have been reported as proxy for per capita consumption. This is incorrect. Per capita consumption data are collected from monitoring data of food consumption in households. GSS claims that monitored food consumption data were collected as part of the national household expenditure survey. The method used by GSS involved monitoring by enumerators embedded in households. SRID should go for the national household expenditure data and extract the household food consumption data to calculate per capita consumption of different commodities. The data presented in the SRID publications	More accurate representation of data in the publication on agriculture in Ghana.	SRID	Immediately (within 1 year)

			reflect stocks of food availability which must be adjusted for losses in storage.			
4	Generation and presentation of aggregate data for all food crops.	SRID presents aggregate data for rice, sorghum and yam, among other food crops. For example, all yam types are classified as "white" yam.	SRID should disaggregate rice (not into paddy and milled but into aromatic and non-aromatic), sorghum (into white and red varieties) and yam (into higher priced 'poona' or 'labreko' and separate these from lower priced white yam)	Relative varietal production figures and prices affect value of production and GDP calculations.	SRID	Short-term (within 1-2 years)
5	Treatment of suspected outliers.	SRID does not use a one size fits all procedure to treat outliers but takes each in its context. After identifying an outlier, SRID explores the data further to understand the underlying causes which then inform how to treat or manage it. In cases where outliers resulted from poor data collection or data entry, the suspected outliers are corrected after confirmation from further field investigations. In other cases, outliers have been replaced with estimated values, e.g. group mean or median or missing values when the outlier prevalence is less than 5% of the data values.	In cases where suspected outliers are not the result of errors in data collection or entry, SRID should use scientifically robust techniques (test for normality, investigation of upper and lower tails of distribution, box plots, histograms etc.) to identify and handle suspected outliers.	Robust analysis and treatment of suspected outliers.	SRID	Short-term (within 1-2 years).
6	Reporting of average yield in Table 4.7 in "Agriculture in Ghana: facts and figures" booklet.	SRID's explanatory notes to Table 4.7 are as follows: "Potential yield (Achievable yield) indicates yields that have been achieved in cases where more effective	The explanatory notes require a lot more clarity on what is meant by achievable yields or potential yields. Are these yields from on-station or on-farm researcher managed plots? Also, extension advice would not fully explain	Better clarity.	SRID	Immediately.

		extension and use of recommended technologies have occurred. The dashes indicate crops for which no on-farm research findings were available as far as achievable yields were concerned. Data on achievable yields have been revised in line with new findings by the Crop Research Institute of the CSIR.	differences between yields obtained by farmers and researchers.			

c. Strengthening institutional links with organizations and agencies collecting similar data or providing SRID with secondary data

	Problem/ issue	SRID practices	Recommended next steps	Advantage(s)	Recommended implementer	Recommended time schedule for implementation
1	Organizations involved in monitoring and the collection of data on imports and exports do not have harmonized data.	SRID collects imports and exports data from specific agencies within or outside MoFA.	SRID should coordinate with GSS as well as relevant agencies collecting imports and exports data and organize data triangulation. The objective is to harmonize data and ensure proper methodologies are followed in collecting and documenting imports and exports data.	Triangulation should improve data accuracy and effective methodologies for cleaning up data collection processes.	SRID	Medium-term (within 3-5 years).
2	Lack of coordination in determining retail prices for food crops collected by SRID, GSS, Esoko.	SRID collects retail prices (in addition to wholesale and farm gate prices) on food commodities while GSS, oblivious of SRID's retail food price data collection activities, also collects retail prices for food commodities and uses the data for calculating CPI. A private firm, Esoko, also collects and broadcasts its retail market prices on TV3.	SRID should contact GSS and Esoko to harmonize methodologies for retail price data collection for food crops, markets visited and coordinate efforts to avoid duplication of efforts and direct these resources to cater for other needs.	Coordination of methodologies, triangulation and harmonization of retail price data on same commodities and markets would be beneficial to SRID.	SRID	Medium-term (within 3-5 years)
3	Transmission of data collected by directorates of MoFA to SRID.	It is not clear whether there is a structured mechanism for transmission of data collected by different directorates of MoFA to SRID.	There is the need for structured (quarterly or bi-annual) transmission of data, together with description of methodologies used to collect data, from all directorates to SRID.	Facilitate ready access to data from all directorates of MoFA at one central database point.	MOFA senior management	Immediate (within 1 year).
4	SRID supervision of Department of Agriculture personnel.	It is not clear if there is a structured mechanism for SRID supervision of Department of Agriculture staff involved in data collection and collation in the Districts, Municipalities and Metropolitan areas.	Official structured mechanism for reporting and supervision.	Facilitate critical SRID methodological guidance and supervision of DoA staff.	MOFA senior management	Short-term (within 1-2 years).

Annex A: Terms of Reference (TOR) for consultancy contract

Scope of Work
USAID/Ghana Agriculture Policy Support Project

Consultancy: Assessment of Methodologies Used to Collect, Collate and Analyze Data on Agricultural Value Chains and Propose New Methodologies

1. Background and Justification

The Statistics, Research and Information Directorate (SRID) of the Ministry of Food and Agriculture (MoFA) is responsible for collecting data on agricultural activities in Ghana on an annual basis. Some of the data collected are; area under cultivation of various crops, export volumes, yields per unit, production volumes, import volumes of selected commodities and products, etc. This data falls into two categories: data collected through survey of a sample of households in all districts, which provides information on production and technology adoption; and data from secondary sources, which provides information on prices, supply of inputs, processing, and trade in commodities.

SRID has as its mandate to provide relevant, accurate and timely agricultural statistics and information for stakeholders to ensure that: agricultural production decisions are based on objective and realistic criteria and; agricultural statistics generated for policy formulation, planning, project implementation, monitoring and evaluation are efficiently communicated within MFA and to the general public. Importantly, production and price information are critical to accurately assess the growth and contribution of agriculture to the overall economy.

Although projects such as Ghana Strategic Support Project (GSSP) has assisted in the development of a survey plan and strategy to improve agricultural statistics in Ghana, the resultant data produced annually has been limited and not robust enough for purposes of generalized decision making. This is due to failure to distinguish between household based production and other types of data. Data collected from secondary sources have been unreliable requiring tedious validation exercises.

This is largely due to dependence on using similar methodologies for collecting primary data on a wide range of value chains and reliance on agencies and institutions who do not ensure rigorous and robust verification of data they generate.

Therefore, there is the need to identify and assess methodologies used for collecting secondary data to help explore other ways of improving the quality of data collection, analysis and dissemination.

SRID is documenting the methodologies that they currently use for collecting primary and secondary data, to set the basis for the current study.

2. Objectives

The objectives/output of the study are:

- To assess and evaluate methodologies used by SRID to collect primary and secondary agricultural data of key commodities in the fruits and vegetables, fisheries, root and tubers, grain staples and livestock value chains
- Document and describe the key assumptions underlying the methodologies
- To assess the various methodologies as to their efficiencies and relevance in identifying, collecting, collating and analyzing data on value chain basis

- To provide new and improved methodologies through desk research and discussions with coordination team for collecting and analyzing data more efficiently and effectively in Ghana on value chain basis sustainably and use two case studies to substantiate the recommended new methodology.
- To decide on information that would be useful to collect data from secondary sources – here there may be a tradeoff between collecting them from households and from other sources; think about opportunities for triangulation; you may want to categorize the information needed: input supply (fertilizer supply, tractors, trucks in agricultural transport, volume of pesticides sold), production (those that are not captured by household (HH) surveys, marketing (volumes that comes into major markets), processing (cassava, oil palm, rice, soya for example), exports of various commodities, imports of inputs and commodities/products to meet consumption needs.
- To take stock of the data that SRID now collects through secondary sources (this could include just asking another agency for information, as well as collecting information from say markets) and assess their reliability
- To explore sources and methods to collect necessary secondary data and subject them to verification.

3. Consultant's Scope of Work /Tasks

The consultant's tasks will include, but not limited to:

- Undertake the necessary steps to fully complete the assignment as per the objectives/output of the study
- Make recommendations on the way forward so the findings of the study contribute effectively to improve methodologies used to collect, collate and analyze data agriculture data

4. Methodology and approach

This research will be conducted based on data provided by SRID and will involve different stakeholders in the agriculture sector involved with data collection and analyses and usage. Such methods may include review of available literature on the subject, Focus Group Discussions (FGDs) based on open ended checklists, using well-structured questionnaires to obtain various responses from key stakeholders involved in agriculture.

Key informant interviews involving both public and private stakeholders will also be conducted. In addition, the consultant(s) will be required to hold discussions with staff at the SRID and the coordination team. A lot of studies have been done on the issues related to the collection of adequate and quality agricultural statistics and therefore the Consultant should focus on interrogating the successes and challenges of the current approaches.

5. Deliverables

At the end of the assignment the consultant will deliver to the MOFA- SRID and APSP the following outputs:

- Detailed concept paper within one week of contract approval
- Detailed work plan covering the duration of the assignment
- A draft report in 3 hard bound copies and one soft copy on a CD-ROM.
- A debriefing workshop where the findings are shared with MoFA- SRID and APSP technical staff and other stakeholders before finalizing.
- A final strategy document with recommendations and incorporating feedback from workshop in 3 hard bound copies and one soft copy (MS word and pdf).

6. Qualifications and experience

- At least a MPhil degree in Agricultural statistics, Statistics, Production Economics or Development Economics with Agriculture bias
- At least 15 years working experience as Agricultural Economist, Agricultural Statistician, Development Economist in the Agricultural sector and Researcher
- Must be familiar with standard survey methods and informal methods for collecting and triangulating data
- Must be computer literate especially in statistical packages and Microsoft office
- Communicate sufficiently in the English Language at the highest level
- Excellent writing and presentation skills
- Ability to meet deadlines

7. Coordination

The study will be coordinated by SRID with support from a coordination team led by Mr. Harrison Opoku (Director SRID) with the following as members; Dr. George T-M. Kwadzo (APSP Advisor), Kwesi Korboe (Technical Advisor MOFA and Lambert Abusah (Director M&E MOFA) and Alabira Ibrahim (M&E and Research Lead, APSP).

8. Calendar

The expert shall be initially engaged for a period of 25 man-days within a period of two calendar months.

Annex B: Non-traditional agricultural exports by product, January to December 2015-2011

a. Year 2015

Agricultural Products	Weight (kgs)	Value (US $)	Value (GH¢)
Cereals			
Rice	468,689	267,207	1,009,288
Cereals nes[1]	39,765	54,678	199,326
Maize seed	59,493	18,198	64,783
Maize	1,716	6,482	24,055
Buckwheat	768	1,297	4,946
Plant seeds	136	150	569
Sub-total	570,567	348,012	1,302,967
Coffee/Tea/Mate/Spices			
Spices nes	708,885	1,260,083	4,514,234
Coffee	174,474	569,516	2,199,702
Dried pepper	368,072	210,288	790,524
Pepper, crushed or ground	81,761	158,806	608,205
Tea	3,690	44,139	153,069
Cinnamon	20	50	187
Sub-total	1,336,902	2,242,882	8,265,921
Dairy Products (Raw)			
Natural honey	25,918	554,871	1,924,720
Eggs	1,778	662	2,321
Sub-total	27,696	555,533	1,927,041
Fish and Seafood			
Fresh or chilled tunas	12,137,933	27,784,832	100,512,454
Fresh or chilled fish, nes	4,043,229	3,694,482	13,499,499
Cuttle fish and squid	600,236	2,165,224	7,952,204
Octopus live, fresh or chilled	420,437	1,637,850	6,054,121
Frozen or fresh lobsters	16,252	129,978	476,245
Dried/smoked/salted fish	10,779	16,957	63,288
Crabs	11,460	12,918	49,796
Sub-total	17,240,326	35,442,241	128,607,607
Game and Wildlife			
Live Animals	52,341	50,863	197,513

[1] Not established

Snails	735	1,140	4,321
Sub-total	53,076	52,003	201,834
Horticultural Products			
Banana	95,179,520	25,442,861	95,204,232
Pineapples	43,460,827	20,539,117	75,853,670
Yams	28,295,794	18,979,689	69,337,554
Mangoes	2,218,536	7,617,556	27,556,353
Coconuts	37,586,392	1,870,968	7,001,602
Spinach	735,019	894,042	3,348,107
Pawpaw	664,218	465,705	1,748,032
Flowers	459,779	441,593	1,524,400
Oranges	5,062,000	309,953	1,126,852
Fruits nes	37,913	302,996	1,161,833
Vegetables, nes	338,236	267,919	999,883
Aubergines	59,624	136,646	507,050
Capsicum	363,825	132,835	486,696
Beans,	163,043	70,954	264,294
Mushrooms	12,446	37,035	158,195
Onions and shallots	198,835	29,976	117,929
Berries	127,632	26,419	100,692
Tamarind	119,003	5,369	18,947
Melons	1,037	3,200	10,249
Asparagus	5,659	2,500	9,488
Kiwi fruit	22,500	2,476	9,450
Apples	10,000	1,476	4,720
Potatoes	1,959	1,464	6,198
Manioc	290	1,218	4,384
Avocados	28	26	99
Garlic	10	10	39
Sub-total	215,124,125	77,584,003	286,560,948
Meat and Meat Offal			
Meat and Meat Offal	40,622	104,553	232,229
Sub-total	40,622	104,553	232,229
Oil Seeds and Nuts			
Cashew nuts	232,835,354	211,327,845	782,470,695
Shea nuts (karite nuts)	134,651,181	33,571,717	121,212,393
Medicinal plants & parts	35,527,540	28,995,008	103,594,628
Palm nuts and kernels	30,508,580	3,318,025	12,594,500

Groundnut	529,400	1,509,533	5,658,724
Brazil nuts	207,266	227,992	800,550
Rape or colza seeds	163,580	122,418	445,663
Pyrethrum	28,120	51,470	167,030
Oil seeds flour	20,000	44,490	150,852
Soya bean flour	2,091	959	3,986
Coca leaf	748	771	2,870
Peas	556	268	1,156
Sub-total	434,474,416	279,170,496	1,027,103,047
Other Agricultural Products			
Cotton linters	598,166	863,859	3,132,250
Fish meal	82,059	262,741	986,263
Peel of citrus fruit or melons,	143,325	148,301	532,459
Sub-total	823,550	1,274,901	4,650,972
Vegetable Saps and Extracts			
Vegetable saps nes	279,750	111,900	419,854
Natural gums	159,321	28,704	111,665
Liquorice sap	30	110	427
Sub-total	439,101	140,714	531,946
Sub-sector total	**670,130,381**	**396,915,338**	**1,459,384,512**

Source: Ghana Exports Promotion Authority

b. Year 2014

Agricultural Products	Weight (kgs)	Value (US$)	Value (GH¢)
Cereals			
Cereals nes	134,351	149,948	441,159
Maize seed	484,390	79,258	225,930
Rice	122,626	62,316	198,910
Maize	198,012	37,482	89,994
Sub-total	**939,379**	**329,004**	**955,993**
Coffee/Tea/Mate/Spices			
Dried pepper	858,633	599,701	1,760,354
Spices nes	233,645	253,310	793,591
Pepper, crushed or ground	207,142	251,435	755,650
Coffee	112,281	168,266	536,310
Tea	86,385	96,464	288,222
Sub-total	**1,498,086**	**1,369,176**	**4,134,127**

Food products (raw)			
Natural honey	198	3,292	7,504
Sub-total	**198**	**3,292**	**7,504**
Fish and seafood			
Fresh or chilled tunas	26,819,891	42,851,223	127,654,538
Fresh or chilled fish, nes	5,769,865	9,993,921	28,336,074
Octopus live, fresh or chilled	442,521	1,999,514	5,691,100
Frozen or fresh lobsters	76,671	930,487	2,790,361
Cuttle fish and squid	113,346	476,360	1,470,600
Dried/smoked/salted fish	22,362	48,597	123,298
Crabs	16,512	21,513	66,662
Sub-total	**33,261,168**	**56,321,615**	**166,132,633**
Game and wildlife			
Live Animals	42,376	105,937	286,996
Snails	10,100	10,522	29,519
Sub-total	**52,476**	**116,459**	**316,515**
Horticultural products			
Yams	35,825,508	18,282,488	52,628,452
Pineapples	33,633,557	17,960,113	51,340,618
Banana	56,075,430	16,699,489	48,700,910
Mangoes	1,275,623	6,246,507	17,791,328
Flowers	278,961	3,218,895	7,937,260
Coconuts	53,380,148	922,297	2,706,465
Oranges	9,025,091	707,093	1,896,810
Vegetables, nes	869,801	705,549	2,116,204
Spinach	756,942	691,318	2,029,067
Pawpaw	1,295,012	595,457	1,759,476
Manioc	277,026	345,078	970,023
Fruits nes	32,163	113,393	336,646
Capsicum	103,896	56,524	180,873
Onions and shallots	237,254	49,473	137,150
Lemons and limes	41,773	49,299	138,449
Beans,	58,169	40,829	110,681
Aubergines	17,240	22,280	70,383
Tamarind	295,760	12,502	31,319
Garlic	14,000	7,700	18,688
Cabbage/lettuce	7,552	5,129	15,561

Melons	70,253	5,063	15,116
Berries	49,760	1,225	3,110
Guavas	1,601	1,046	3,042
Tomatoes	371	601	1,535
Pears and quinces	250	73	220
Peas,	196	53	157
Potatoes	43	33	79
Mushrooms	4	30	68
Asparagus	41	10	31
Celery	14	3	10
Sub-total	**193,623,439**	**66,739,550**	**190,939,731**
Oil seeds and nuts			
Cashew nuts	192,375,942	134,614,317	375,155,058
Medicinal plants & parts	68,337,679	51,991,308	139,636,298
Shea nuts (karite nuts)	59,909,221	25,046,473	77,279,971
Palm nuts and kernels	18,002,587	1,764,216	5,047,570
Brazil nuts	344,486	344,486	917,900
Cotton seed	509,279	90,792	240,908
Soya bean flour	35,345	43,014	137,478
Oil seeds flour	13,668	32,877	88,355
Kola nuts	134,600	26,786	80,890
Almonds	386	3,099	7,762
Coca leaf	3,191	1,871	5,620
Safflower seeds	119	348	973
Forage products nes	102	50	151
Sub-total	**339,666,605**	**213,959,637**	**598,598,934**
Other agricultural products			
Cotton linters	177,496	333,692	809,869
Peel of citrus fruit or melons	282,171	291,741	818,984
Sub-total	**459,667**	**625,433**	**1,628,853**
Vegetable Saps and Extracts			
Natural gums	1,965,840	1,168,074	3,136,602
Vegetable saps nes	120,000	51,600	160,027
Hop sap	16,000	3,879	12,400
Sub-total	**2,101,840**	**1,223,553**	**3,309,029**
Sub-sector total	**571,602,858**	**340,687,719**	**966,023,319**

Source: Ghana Exports Promotion Authority

c. Year 2013

Agricultural Products	Weight (kgs)	Value (US$)	Value (GH¢)
Cereals			
Maize seed	3,335,368	325,053	648,022
Maize	1,535,394	248,952	497,995
Rice	143,691	115,272	227,415
Cereals	31,347	64,040	129,634
Millet	3,699	2,590	4,940
Plant seeds	312	100	191
Sorghum	7	6	11
Sub-total	**5,049,818**	**756,013**	**1,508,208**
Coffee/Tea/Mate/Spices			
Coffee	918,228	4,277,876	8,282,998
Dried pepper	984,503	586,089	1,157,244
Tea	29,486	412,632	823,976
Spices	119,004	135,213	267,483
Pepper, crushed or ground	95,379	107,091	209,691
Ginger	13,481	3,603	6,865
Nutmeg	42	144	275
Sub-total	**2,160,123**	**5,522,648**	**10,748,532**
Dairy and natural products (raw)			
Eggs	55,028	8,910	16,144
Natural honey	947	1,708	3,330
Sub-total	**55,975**	**10,618**	**19,474**
Fish and Seafood			
Fresh or chilled tunas	6,495,517	24,390,031	48,467,344
Fresh or chilled fish	7,008,241	7,695,808	15,140,195
Octopus live, fresh or chilled	129,059	460,611	927,834
Frozen or fresh lobsters	43,601	376,808	760,051
Dried/smoked/salted fish	149,095	164,591	326,264
Crabs	9,254	11,458	22,332
Cuttle fish and squid	579	3,219	6,128
Live ornamental fish	1,420	1,991	3,795
Shrimps and prawns	66	80	152
Sub-total	**13,836,832**	**33,104,597**	**65,654,095**
Game and Wildlife			
Live Animals	73,078	420,338	801,487

Snails	7,191	9,555	18,884
Sub-total	**80,269**	**429,893**	**820,371**
Horticultural products			
Yams	28,200,406	20,857,985	41,469,691
Pineapples	40,095,385	19,208,877	38,129,977
Mangoes	1,788,647	5,110,721	10,106,160
Flowers	766,209	2,326,368	4,545,077
Banana	8,656,081	2,287,010	4,360,129
Coconuts	16,482,092	1,532,699	3,031,310
Manioc	548,771	1,207,624	2,408,846
Vegetables, nes	1,310,084	1,201,568	2,366,391
Pawpaw	1,118,498	713,424	1,406,376
Spinach	844,489	602,317	1,192,628
Oranges	8,232,737	534,293	1,039,830
Onions and shallots	635,280	139,828	254,011
Fruits nes	125,477	111,150	223,351
Sweet corn	43,863	100,099	191,120
Lemons and limes	44,928	99,252	190,118
Cherries	206,385	51,596	103,054
Beans,	24,331	33,344	69,187
Plantain	55,135	24,640	46,956
Melons	58,228	24,280	47,580
Guavas	4,228	22,645	44,243
Cocoyam	52,942	20,166	38,417
Tomatoes	17,425	15,121	25,483
Tamarind	211,840	13,546	25,928
Berries	89,961	11,654	23,538
Asparagus	5,210	10,363	20,788
Potatoes	13,366	9,987	18,194
Aubergines	10,925	7,899	15,475
Cabbage/lettuce	1,816	7,893	13,719
Apples	2,705	6,281	9,846
Grapes	741	3,891	3,878
Carrots and turnips	558	1,866	3,007
Avocados	762	1,270	1,973
Celery	161	1,110	2,217
Cucumbers	438	619	788
Capsicum	70	576	1,152
Cauliflowers and broccoli	189	470	940
Mushrooms	662	357	698

Pears and quinces	654	278	530
Mushrooms	187	250	496
Peas,	80	200	400
Brussels sprouts	70	175	350
Olives	33	164	326
Kiwi fruit	19	15	29
Garlic	3	9	17
Sub-total	**109,652,071**	**56,303,880**	**111,434,224**
Meat and Meat Offal			
Meat and Meat Offal	72,363	152,742	306,835
Sub-total	**72,363**	**152,742**	**306,835**
Oil seeds and nuts			
Cashew nuts	271,536,794	155,628,466	303,517,062
Medicinal plants & parts	54,048,906	43,116,561	85,301,606
Shea nuts (karite nuts)	37,517,888	8,062,696	15,371,928
Nuts	12,017,887	7,468,305	14,241,603
Groundnut	1,257,908	6,339,606	7,649,589
Palm nuts and kernels	62,822,759	4,380,688	8,624,365
Cotton seed	2,983,862	927,941	1,799,839
Brazil nuts	269,664	175,281	350,350
Kola nuts	527,200	93,258	177,868
Hop cones	17,000	39,950	77,663
Coca leaf	4,998	13,362	27,381
Soya bean flour	84,067	1,441	2,889
Oil seeds flour	500	830	1,580
Cereal husks	471	40	77
Sunflower seeds	1	3	6
Sub-total	**443,089,905**	**226,248,428**	**437,143,806**
Other agricultural products			
Peel of citrus fruit or melons	222,911	278,772	557,130
Fish meal	1,576	3,950	7,751
Sub-total	**224,487**	**282,722**	**564,881**
Vegetable Saps and Extracts			
Natural gums	1,035,857	514,439	1,010,873
Pectinates and pectates	30,558	290,097	576,018
Mucilages	37,358	82,649	164,236
Vegetable saps nes	1,112	10,870	20,741

Sub-total	**1,104,885**	**898,055**	**1,771,868**
Sub-sector total	**575,326,728**	**323,709,596**	**629,972,294**

d. Year 2012

Agricultural Products	**Weight (kgs)**	**Value (US$)**	**Value (GH¢)**
Cereals			
Maize seed	1,195,541	122,064	234,299
Oats	49,606	83,994	155,035
Cereals nes	94,074	56,795	105,549
Rice	72,342	54,314	102,580
Maize	50,970	6,949	11,903
Millet	2,370	838	1,489
plant seeds	409	124	209
Barley	7	4	8
Sub-total	**1,465,319**	**325,082**	**611,072**
Coffee/Tea/Mate/Spices			
Coffee	48,514,100	12,130,654	22,137,033
Dried pepper	734,000	720,911	1,317,386
Pepper, crushed or ground	89,195	143,801	262,298
Spices nes	153,519	66,724	124,333
Tea	4,730	26,214	50,188
plant seeds	4,210	21,394	34,442
Ginger	1,162	884	1,636
Sub-total	**49,500,916**	**13,110,582**	**23,927,316**
Dairy and natural products (raw)			
Eggs	282,517	68,407	128,984
Natural honey	17,144	46,726	75,671
Sub-total	**299,661**	**115,133**	**204,655**
Fish and Seafood			
Fresh or chilled tunas	19,798,615	44,998,718	85,598,244
Fresh or chilled fish, nes	10,296,808	13,940,061	25,458,112
Octopus live, fresh or chilled	266,243	899,286	1,487,745
Cuttle fish and squid	146,087	556,027	932,799
Frozen or fresh lobsters	13,973	87,924	161,438
Dried/smoked/salted fish	155,032	77,066	139,336
Crabs	9,952	10,398	17,346
Shrimps and prawns	4,151	4,300	8,153

Live ornamental fish	1,213	2,206	3,934
Sub-total	**30,692,074**	**60,575,986**	**113,807,107**
Game and Wildlife			
Live Animals	35,464	316,706	596,490
Snails	1,715	2,054	3,878
Sub-total	**37,179**	**318,760**	**600,368**
Horticultural products			
Pineapples	41,211,912	16,815,539	30,690,522
Banana	60,424,502	15,317,326	28,005,549
Yams	25,079,360	12,251,121	22,251,102
Mangoes	1,222,332	2,688,654	5,010,557
Flowers	811,814	2,025,099	3,692,904
Vegetables, nes	1,959,601	1,215,441	2,276,950
Coconuts	4,102,255	1,004,539	1,890,700
Beans,	7,111,770	418,094	1,150,126
Oranges	7,588,948	482,841	875,128
Apricots	899,400	180,591	342,503
Spinach	113,348	143,265	271,841
Pawpaw	425,512	136,422	245,151
Fruits nes	91,725	102,490	195,466
Guavas	8,138	69,690	131,888
Soya beans	301,001	59,499	109,988
Onions and shallots	316,343	59,160	106,686
Tomatoes	59,852	36,745	68,283
Plantain	77,829	28,578	53,273
Aubergines	17,536	27,248	51,371
Asparagus	7,099	23,615	45,292
Pears and quinces	343,518	13,526	24,378
Berries	378,774	13,149	22,604
Cocoyam	32,723	11,314	21,442
Apples	13,347	6,545	11,843
Potatoes	8,034	4,799	9,021
Melons	6,471	4,183	7,932
Cabbage/lettuce	7,053	3,893	7,334
Grapes	5,074	2,935	5,510
Garlic	4,866	2,408	4,587
Lemons and limes	5,757	2,034	3,634
Avocados	2,647	1,691	3,217
Capsicum	1,003	1,326	2,409

Carrots and turnips	3,045	1,265	2,345
Cucumbers	2,377	1,109	2,098
Tamarind	8,588	591	1,065
Sweet corn	92	46	88
Sub-total	**152,653,646**	**53,156,771**	**97,594,787**
Meat and Meat Offal			
Meat and Meat Offal	20,857	137,815	266,829
Sub-total	**20,857**	**137,815**	**266,829**
Oil Seeds and Nuts			
Cashew nuts	157,175,690	91,289,689	169,744,015
Shea nuts (karite nuts)	108,976,341	26,337,963	48,109,986
Medicinal plants & parts	22,391,413	14,198,430	26,310,308
Groundnut	1,907,073	6,008,791	11,354,392
Nuts nes	3,163,286	3,187,007	5,838,414
Brazil nuts	3,169,388	2,102,403	3,682,414
Peas,	3,105,000	1,343,957	2,608,935
Soya bean flour	1,420,165	1,096,917	2,095,380
Cotton seed	7,076,806	969,805	1,746,453
Kola nuts	1,758,400	392,905	744,296
Palm nuts and kernels	4,460,500	261,965	46,800
Pistachio	8,757	16,216	30,149
Cereal husks	5,788	13,741	23,170
Oil seeds flour	17,977	8,111	13,766
Walnuts	333	500	851
Coca leaf	2,225	341	653
Rape or colza seeds	244	18	31
Sub-total	**314,639,386**	**147,228,759**	**272,350,013**
Other Agricultural Products			
Cotton linters	2,213,480	507,916	984,153
Peel of citrus fruit or melons	90,885	82,086	144,971
Fish meal	716	3,954	7,678
Sub-total	**2,305,081**	**593,956**	**1,136,802**
Vegetable Saps and Extracts			
Natural gums	1,008,092	670,432	1,238,641
Mucilages	527,614	152,765	291,766
Sub-total	**1,535,706**	**823,197**	**1,530,407**

Sub-sector total	553,149,825	276,386,041	512,029,356

e. **Year 2011**

Agricultural products	Weight (kgs)	Value (US$)	Value (GH¢)
Cereal			
Rice	1,243,194	706,590	957,926
Maize seed	30,169	117,101	178,560
Oats	44,847	82,504	126,802
Sorghum	37,942	28,454	43,811
Cereals nes	37,355	19,407	29,576
Maize	44,572	15,258	23,814
Millet	1,914	2,200	1,176
Wheat	70	70	108
Plant seeds	44	27	40
Barley	36	21	32
Sub-total	**1,440,143**	**971,632**	**1,361,845**
Coffee/Tea/Mate/Spices			
Coffee	9,034,687	8,980,193	13,580,653
Pepper, crushed or ground	136,953	809,838	210,462
Spices nes	141,525	379,303	349,956
Dried pepper	865,757	375,126	512,923
Plant seeds	179,400	57,966	87,933
Ginger	23,969	26,662	7,209
Vanilla	52	3,760	126
Tea	1,176	1,150	1,753
Sub-total	**10,383,519**	**10,633,998**	**14,751,015**
Dairy and natural products (raw)			
Eggs	30,737	115,318	22,182
Natural honey	803	17,836	3,747
Sub-total	**31,540**	**133,154**	**25,929**
Fish & Seafood			
Fresh or chilled fish, nes	7,972,347	17,087,721	22,988,937
Fresh or chilled tunas	4,707,373	10,268,590	14,922,765
Cuttle fish and squid	398,284	3,236,791	2,838,898
Octopus live, fresh or chilled	161,489	1,249,840	1,103,087
Frozen or fresh lobsters	29,019	227,008	113,029
Dried/smoked/salted fish	54,643	183,301	109,897

Crabs	15,415	32,920	24,337
Shrimps and prawns	12,248	29,580	39,655
Live ornamental fish	13,127	22,852	35,105
Oysters	36,000	1,131	1,800
Sub-total	**13,399,945**	**32,339,734**	**42,177,510**
Game & wildlife			
Live Animals	542,032	427,846	657,088
Snails	3,214	2,870	4,436
Sub-total	**545,246**	**430,716**	**661,524**
Horticultural products			
Pineapples	45,057,147	16,972,432	25,770,971
Banana	63,761,395	15,357,367	23,540,612
Yams	27,392,738	12,729,933	18,941,970
Mangoes	868,838	2,329,556	2,785,733
Flowers	452,358	2,046,577	3,070,889
Vegetables, nes	2,662,512	1,943,988	2,233,205
Beans,	6,480,517	774,157	1,026,035
Onions and shallots	2,296,557	513,575	637,171
Fruits nes	87,314	486,165	166,060
Pawpaw	919,696	447,606	681,032
Cherries	390,158	227,033	346,625
Oranges	3,811,899	226,167	298,995
Plantain	212,411	182,346	239,559
Cabbage/lettuce	42,239	171,238	90,354
Apples	16,377	162,794	41,688
Apricots	408,000	157,500	242,613
Coconuts	374,667	124,276	169,704
Tomatoes	13,397	103,833	42,579
Mushrooms	1,331	88,552	4,033
Aubergines	78,139	82,573	117,220
Carrots and turnips	2,358	70,722	4,899
Soya beans	35,195	60,070	94,649
Cauliflowers and broccoli	882	58,882	2,525
Potatoes	11,588	51,412	11,052
Cocoyam	61,495	51,179	65,038
Peas,	20,484	49,251	7,418
Spinach	49,734	44,889	67,011
Grapes	997	40,950	1,426
Sweet corn	889	38,500	3,464

Lemons and limes	56,155	24,576	28,467
Celery	532	21,840	761
Cucumbers	6,092	18,183	15,872
Brussels sprouts	301	17,348	969
Melons	714	16,610	927
Pears and quinces	220,366	14,973	16,218
Dates	26,710	5,778	8,797
Garlic	133	5,460	190
Berries	104,828	4,440	6,802
Avocados	139	3,690	142
Manioc	1,503	3,160	4,787
Tamarind	19,200	2,429	3,720
Asparagus	4,737	2,360	3,528
Guavas	5	3	4
Sub-total	**155,952,727**	**55,734,373**	**80,795,714**
Meat and Meat Offal			
Meat and Meat Offal	79,260	1,141,002	147,515
Sub-total	**79,260**	**1,141,002**	**147,515**
Oil Seeds and Nuts			
Cashew nuts	215,587,475	149,714,740	229,027,142
Shea nuts (karite nuts)	111,194,139	25,086,810	38,690,358
Medicinal plants & parts	21,261,098	16,580,440	25,241,483
Cotton seed	3,530,414	758,078	1,163,604
Nuts nes	9,609,379	733,610	1,120,165
Brazil nuts	523,957	727,165	1,106,321
Groundnut	88,921	598,656	195,539
Kola nuts	1,185,500	258,650	395,666
Soya bean flour	176,593	185,915	240,976
Rape or colza seeds	28,280	43,898	65,390
Palm nuts and kernels	221,900	31,803	48,660
Sunflower seeds	14,000	28,000	42,588
Pistachio	1,907	17,360	5,471
Oil seeds flour	4,574	5,783	5,213
Cereal husks	3,791	2,251	3,431
Coca leaf	566	1,517	326
Copra	68	190	150
Sub-total	**363,432,562**	**194,774,866**	**297,352,483**
Other Agricultural Products			

Cotton linters	1,193,580	253,177	385,913
Fish meal	29,869	186,612	178,339
Peel of citrus fruit or melons,	174,663	173,843	266,521
Sub-total	**1,398,112**	**613,632**	**830,773**
Vegetable Saps and Extracts			
Natural gums	402,070	202,344	305,506
Sub-total	**402,070**	**202,344**	**305,506**
Sub-sector total	**547,065,124**	**296,975,451**	**438,409,814**

Source: Ghana Export Promotion Authority

Annex C: Vet recording form 14

Veterinary Services Directorate

Importation Returns

Period: April, 2016 **Region** **VET. Form 14 (VF 14)**

District	Point of Entry	Origin of Product	Destination	Species/Processed	Total
Total					

Annex D: Imports of livestock 2010-2016

Imports of Livestock Products 2009-2014					Imports of livestock, 2010-2016					
Year	Day Old Chicks				Poultry Meat Imports					
	Broiler	Layer	Turkey	Hatching eggs	Parent stock	Guinea Fowls	Cockerels	Chicken	Duck	Turkey
2010	361,167	1,412,334	112,290	365,074	0	0	0	69,810,787	0	1,351,719
2011	547,205	246,140	9,180	346,110	0	0	0	86,372,352	4,000	1,033,125
2012	651,112	3,227,844	16,966	306,765	114,344	8,415	314	73,788,430	78,260	1,293,720
2013	1,088,865	1,181,602	9,286	435,509	126,288	21,540	1,905	58,996,348	0	1,786,974
2014	602,209	315,114	6,840	736,560	116,560	18,080	0	13,461,028	0	645,372
2015	246,948	2,573,326	5,497	0	111,692	5,160	0	35,369,069	0	772,406
2016	199,743	2,066,705	540	195,320	63,488	8,040	0	940,640	0	14,000
TOTAL	**3,697,249**	**11,023,065**	**160,599**	**2,385,338**	**532,372**	**61,235**	**2219**	**338,738,654**	**82260**	**6,897,316**