

Verification of Certification Activities in West African Cocoa Sector

Review of Statistical Weighting Report: Ghana

September 2009

This report describes the findings of a review on statistical weighting report made on scaled-up certification study by the government of Ghana. The review from which the findings are derived was conducted by Fafo commissioned by the International Cocoa Verification Board (ICVB). The findings of the study offer recommendations on technical aspects of statistical weighting that will refine the quality of the study made on child labor in cocoa production sector.

Anne Hatløy

Tewodros Aragie Kebede

1. Background and materials

In 2007/8 the government of Ghana conducted a certification study with the objectives of estimating child labor and worst forms of child labor (WFCL) in cocoa production sector, as well as documenting the incidence of forced adult labor (MMYE/NPECLC 2008). Commissioned by the International Cocoa Verification Board (ICVB), Fafo and Khulisa conducted verification activities on the results reported in the study to evaluate the credibility and the scientific basis of the study. Fafo and Khulisa recommended to the ICVB the unconditional acceptance of the study. The verification report also noted that the results reported in the scaled-up study are valid to the selected sample and the results could not be generalized to all cocoa growing households in Ghana. To this end, the verifiers made a recommendation that these results can be made to be statistically representative and valid for all cocoa growing regions in Ghana if the appropriate statistical weights are computed and employed to the results reported in the study. This recommendation was implemented by the government of Ghana with a clear objective of enhancing the validity of the scaled-up study and presented a revised report in August 2009. These revised results are the subject of this report in which the findings of the review are discussed.

The materials that are used in reviewing the weighting reports are:

- MESW/NPECLC (2009): Report on Weighted Data on Cocoa Labour Survey in Ghana (Scale-up study, 2007/2008).
- MMYE/NPECLC (2008): Cocoa Labour Survey in Ghana-2007/8; June 2008.

This assessment report is organized by presenting the purpose of statistical weighting in section two. Section three discusses the findings of the review by referring to the technical details of statistical weighting and referring to the appropriate mathematical formulas that should be used for computing weights. Since statistical weighting is a result of the design of the sample survey, close reference is made to the description of the sample design that involves three stages. Each of the three stages is reviewed and the findings are discussed. The final section makes recommendation for the way forward.

2. What is the objective of statistical weighting?

Information on characteristics of populations is constantly needed by various decision makers for planning and designing specific policies that address a given problem. For reasons relating to timeliness and cost, such information is often obtained by use of sample surveys.

The scaled-up study in both Cote d'Ivoire and Ghana was conducted to obtain information about children's engagement in cocoa production as well as documenting the incidences of worst forms of child labor and forced adult labor practices. Formally, a sample survey may be defined as a study involving a subset (or sample) of individuals selected from a larger population. Variables of interest are observed or measured on each of the sampled individuals. These measurements are then aggregated over all individuals in the sample to obtain summary statistics (e.g. means, proportions, totals) for the sample. It is from these summary statistics that extrapolations can be made concerning the entire population.

Sampling weights are needed to correct for features in the sample that might lead to bias and other departures between the sample and the reference population. Such features include the selection of units with unequal probabilities, non-coverage of the population, and non-response. Sampling weights are not needed if the characteristics of the sample do not require the application of weights to generalize the results to the reference population. Such cases include when the sample is a simple random sample or the sample is a self-weighting sample. In case of the certification studies, sample weights are needed to generalize the results to all cocoa producing households in Ghana. The objective of weighting that is relevant for the purpose of the certification study in Ghana is the need to compensate for unequal probabilities of selection while other reasons such as non-response can also be taken into account.

The development of sampling weights usually starts with the construction of the base weight for each sampled unit, to correct for their unequal probabilities of selection. In general, the base weight of a sampled unit is the reciprocal of its probability of selection into the sample. For example, a sampled unit selected with probability $1/50$ represents 50 units in the population from which the sample was drawn. Thus sample weights act as inflation factors to represent the number of units in the survey population that are accounted for by the sample unit to which the weight is assigned. The sum of the sample weights provides an unbiased estimate of the total number of individuals in the target population.

3. Review of weighting procedure: findings

The sample used in the scaled-up study was constructed as a three stage stratified cluster sample, limited geographically to the six cocoa producing regions in Ghana. In the first stage, the unit of

selection is *district*, in the second stage is an *enumeration area* (EAs) and in the last stage the unit of selection is a cocoa producing *household*. Development of sampling weights usually starts with the construction of the *base weight* for each sampled unit, to correct for their unequal probabilities of selection. The base weights must reflect the probabilities of selection at each stage. In reviewing the computations of weights outlined in the weighting report (MESW/NPECLC, 2009), we followed the design stages and identified the right formulas that should be used for calculating the probability of selection of the unit in a given stage. The assessment of the three stages is presented as follows.

First Stage: Error Identified

In selecting a district from a given region, the criterion that was used was the amount of cocoa production level in 2003/4 for that district and region. Hence, the districts were selected using a systematic method with probability proportional to the size, and size being the production level for the year 2003/2004 as specified in the scaled up report (MMYE/NPECLC, 2008 page 43.)

For such characterization of the first stage, the formula that is described in the weighting report (MESW/NPECLC (2009), page 22, section 4.3.1) is:

$$p_{i1} = \frac{\text{number of EAs in the } i^{\text{th}} \text{ district}}{\text{number of EAs in that region}}$$

This formula is **incorrect** since it does not take into account the amount of cocoa production at the district and regional level that was used for selecting the districts. The appropriate formula **should have been**

$$p_{r,d} = \frac{M_{r,d}n_r}{M_r}$$

where $M_{r,d}$ is cocoa production level in each district and region (d for district and r for region); n_r is number of districts sampled in each region; and M_r is cocoa production level in each region.

Second stage: Error Identified

The second stage involves the selection of enumeration areas (EAs) using probability proportional to size where size is the number of households. This is described in detail on pages 46-47 of the scaled-up report (MMYE/NPECLC, 2008.)

For such description of the sampling procedure, the formula that is presented in the weighting report (MESW/NPECLC (2009), page 22, section 4.3.1) is:

$$P_{j2} = \frac{\text{number of total households in the } j^{\text{th}} \text{ EA}}{\text{number of EAs in that district}}$$

However, this formula is **incorrect** since it does not take into account the number total cocoa producing households in each district. The formula that **should have been** used for computing the probability of selecting an EA in a given district is:

$$p_{r,d,e} = \frac{N_{r,d,e,h} n_{r,d,e}}{N_{r,d,e}}$$

where $N_{r,d,e,h}$ is the total number of cocoa producing households in each selected EA (e for EA and h for household); $n_{r,d,e}$ is the number of EAs sampled from selected district; and $N_{r,d,e}$ is the total number of cocoa producing households in each selected district.

Third stage: No Error

At the third stage, the inclusion probability of households is obtained as:

$$P_{r,d,e,h} = \frac{n_{r,d,e,h}}{N_{r,d,e,h}}$$

where $n_{r,d,e,h}$ is the number of households interviewed in each selected EA and $N_{r,d,e,h}$ is the total number of households in each selected EA. At this stage, the formulas that are used in the weighting report are similar and hence no error is introduced on this level.

Suggestions for correcting errors

The two errors identified in the first two stages can be corrected by applying the right formula in each of the first two stages. The use of appropriate formulas will result in the overall inclusion probability for households that can be given by:

$$P_i = P_{r,d} \cdot P_{r,d,e} \cdot P_{r,d,e,h} = \frac{M_{r,d} n_r n_{r,d,e} n_{r,d,e,h}}{M_r N_{r,d,e} N_{r,d,e,h}}$$

Based on this, the appropriate sampling weight for households and adult workers/children that **should be used** is given by:

$$W_i = \frac{1}{P_i}$$

To provide guidance in correcting the errors, the appropriate formulas are summarized in Table 3.1 together with an indication in what stage the error is made.

Table 3.1 Summary of appropriate formulas and errors found

| Stage | Selected unit | Probability of Selection | Notation | Error found |
|---|-----------------------|--|--|-------------|
| I | District | $p_{r,d} = \frac{M_{r,d}n_r}{M_r}$ | $M_{r,d}$: Cocoa production level in each district n_r : Number of districts sampled in each region M_r : Cocoa production level in each region | Yes |
| II | Enumeration area (EA) | $p_{r,d,e} = \frac{N_{r,d,e,h}n_{r,d,e}}{N_{r,d,e}}$ | $N_{r,d,e,h}$: Total number of households in each selected EA $n_{r,d,e}$: Number of EAs sampled from selected district $N_{r,d,e}$: Total number of households in each selected district | Yes |
| III | Household | $p_{r,d,e,h} = \frac{n_{r,d,e,h}}{N_{r,d,e,h}}$ | $n_{r,d,e,h}$: Number of households interviewed in each selected EA $N_{r,d,e,h}$: Total number of households in each selected EA | No |
| Overall probability of selection | | $p_i = p_{r,d} \cdot p_{r,d,e} \cdot p_{r,d,e,h} = \frac{M_{r,d}n_r n_{r,d,e} n_{r,d,e,h}}{M_r N_{r,d,e} N_{r,d,e,h}}$ | | |
| Formula for sampling weight: | | $W_i = \frac{1}{p_i}$ | | |

4. Summary and recommendations

The objective of this review has been to assess how statistical weighting was employed on the new report released by the government of Ghana (MESW/NPECLC, 2009). Based on the materials presented, we have reviewed the procedures described in computing statistical weights. Our findings indicate that, two errors were made in calculating the statistical weights that resulted from using an incorrect formula in the calculation of probabilities of inclusion for district and enumeration areas in stage one and two of the sample design. The errors introduced in these stages will have an implication in that the overall probabilities and hence the resulting statistical weights will be wrong. It is important to note that in computing the weights, the implication on actual results can be quantified to assess whether it will decrease or increase a given estimate such as the percentage of children working in hazardous cocoa activities. However, such assessment need not be necessary as it is simply an error that is quantifiable and focus should be made to correct the results by using the right formulas. These errors need to be corrected based on the right formulas summarized in Table 3.1. This report did not address additional assessment on the results reported in MESW/NPECLC (2009) as the identified errors will result in incorrect results.

Based on our assessment on the weighting report (MESW/NPECLC, 2009), the reported results are different in terms of content from the original scaled up certification study report (MMYE/NPECLC 2008.) For the purpose of providing weighted results on the scaled up study, it is sufficient to apply the appropriate weights without having to produce a whole set of different results.

Finally, it is important to note that verification can be conducted at various stages addressing various aspects of the subject in which the verification is made upon. On technical issues such as statistical weighting, close consultations between verifiers and the governments would have been efficient in terms of allocation of resources needed for conducting the task and the impact this important undertaking has on policy implications. The improvements suggested in this report need to be further discussed with the government of Ghana technical experts to ensure that an understanding is made about conceptual and technical approaches on the issues of statistical weighting as well as the implementation of the weights.