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Guidelines on the measurement of harvest and post-harvest losses

Estimating harvest and post-harvest losses in Zambia

Meat and milk

FIELD TEST REPORT



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Abstract

This technical report provides findings of a field test conducted in identified districts / study area in Zambia on the basis of sampling methodology for estimation of harvest and post-harvest losses of animal products (meat and milk) developed by the team led by Dr. Tauqueer Ahmad, Head, Division of Sample Surveys, Indian Agricultural Statistics Research Institute, Institute of Indian Council of Agricultural Research (ICAR-IASRI), New Delhi, India. The Technical Report entitled “Findings from the field test conducted on estimating harvest and post-harvest losses in Zambia. Meat and milk” contains details of findings of the developed methodology implemented in Zambia including challenges encountered and lessons learnt. It is expected that this report will help the users from different countries in designing surveys for measurement of harvest and post-harvest losses of animal products (meat and milk).

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Abbreviations and acronyms

CAPI	Computer assisted personal interviewing
CDF	Commercial dairy farms
Co-PI	Co-personal interviewer
FAO	Food and Agriculture Organization of the United Nations
GSARS	Global Strategy to Improve Agricultural and Rural Statistics (GSARS)
IASRI	Indian Agricultural Statistics Research Institute
ICAR	Indian Council of Agricultural Research
PI	Personal interviewer
SDGs	Sustainable Development Goals
SRSWOR	Simple random sampling without replacement

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1. Introduction

1.1 Background

The Global Strategy to Improve Agricultural and Rural Statistics (GSARS) provides the framework essential to meet the current and emerging data requirements and the demands of policy makers and other data users so that they can fill these urgent needs. The Statistics Division of Food and Agriculture Organization of the United Nations (FAO), Rome has established a global office to lead and coordinate the implementation of Global Strategy to Improve Agriculture and Rural Statistics adopted by United Nations Statistical Commission 2010.

One of the key programmatic areas of FAO is the measurement of country's progress towards achieving Sustainable Development Goals (SDG). SDG 12.3 has set the target that "By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses." The target is two-fold and requires different approaches and thus separate indicators to focus first on the 'reduction of losses along the food production and supply chains' (supply oriented) and second on measuring 'halving per capita global food waste at the retail and consumer level' (demand oriented). The target and indicator belong to Tier III, i.e. those indicators for which an internationally agreed methodology is not yet developed, and data are largely unavailable. FAO adopted a two-pronged approach for addressing the lack of data by improving data collection and estimation methods for missing information.

The FAO organized an Expert Consultation on SDG 12.3 – Measurement and action to meet the target on reducing food losses and food waste held at FAO Headquarters, Rome, Italy during 28-29 September 2017. Dr. Tauqueer Ahmad presented the Indian experience of developing a sampling methodology for estimation of post-harvest losses for 45 crops and commodities that include grains, fruits, vegetables, milk, meat, and fish for India. The advantage of this methodology is that, although it was developed for India, it is applicable to most countries.

Based on this country experience, a sampling methodology was developed for estimating post-harvest losses of cereals and pulses using double sampling approach to implement cost-effective data collection and improved methods for estimating post-harvest losses.

This approach was expanded to other commodities like fruits and vegetables, milk and meat, and fish products. In collaboration with the Indian Agricultural Statistics Research Institute, Institute of Indian Council of Agricultural Research (ICAR-IASRI), FAO developed guidelines to meet the growing demand from countries for methodological guidance and technical assistance in form of three guidelines particularly on (i) fruits and vegetables, (ii) milk and meat, and (iii) fish products. Each set of guidelines captures the differences in the measurement methods, economic actors, value chains, sampling design, sample size and estimation procedure that are different across commodity group and sub-sectors. The primary objective is to identify, test and recommend cost-effective and statistically sound methods to measure post-harvest losses on and off the farm, i.e. among the value chain entities such as commercial producers, farmers, traders, transporters, processors, and others, to determine the extent of various types of losses at critical times. The ICAR-IASRI has developed sampling methodologies for the different commodity groups and corresponding three guidelines (Annexes) for estimation of post-harvest losses of fruits and vegetables, livestock (meat and milk) and fish. To validate the guidelines, field testing of the developed methodology for estimation of harvest and post-harvest losses of fruits and vegetables, livestock (meat and milk) and fish in two / three countries were conducted. This report presents the results and lessons learnt on food loss measurement in meat and milk.

1.2 Objectives

The objectives of the field test on harvest and post-harvest food loss measurement in meat and milk were:

- To test whether operational definitions are relevant and applicable
- To test the proposed approach of sampling design and questionnaire design
- To test primary data collection based on the guidelines for a limited number of commodities, critical loss points and sample size

1.3 Approach

The focus of the approach is on combining enquiry and actual measurement methods for measuring harvest and post-harvest losses using statistical procedures. Further, a sample survey approach is proposed for estimation of harvest and post-harvest losses of meat and milk. The developed methodology tested for meat and milk in Zambia keeps in view the existing agricultural statistics system of the country. The primary data collection was carried out through Computer assisted personal interviewing (CAPI).

The developed guidelines were tested in Zambia under the supervision of Central Statistical Office and the Ministry of Agriculture, Zambia. In the beginning of July 2018, FAO proposed to the Zambian Central Statistical Office to carry out a pilot test to validate the methodology of food loss indicators SDG 12.3 in milk and meat. The guidelines are based on the methodology for measurement of food loss developed by the Indian Agricultural Statistics Research Institute, Institute of Indian Council of Agricultural Research (ICAR-IASRI). A special feature of this methodology is that it combines the survey (face-to-face interviews) and direct measurement (taking samples of the product in the field) of food losses.

1.4 Study area and commodities covered

Zambia

The Republic of Zambia is situated in South-Central Africa, surrounded by eight neighbouring countries; Democratic Republic of the Congo to the north, United Republic of Tanzania to the northeast, Malawi to the east, Mozambique to the southeast, Zimbabwe and Botswana to the south, Namibia to the southwest, and Angola to the west. The capital city of Zambia is Lusaka. The country is divided into ten Provinces, the provinces are divided into districts, and districts are further divided into agricultural camps including veterinary camps.

The climate of Zambia is tropical, modified by elevation. In the Köppen climate classification, most of the country is classified as humid subtropical or tropical wet and dry, with small stretches of semi-arid steppe climate in the south-west and along the Zambezi valley.

There are three main seasons in Zambia – cool and dry from May to August, corresponding to winter, hot and dry from September to November, corresponding to summer and the warm and wet season from December to April. Only in the Valleys of the Zambezi and Luangwa is there excessive heat, particularly in October and, in the wet season, a high humidity. Average monthly temperatures remain above 20 °C (68 °F) over most of the country for eight or more months of the year.

In the present study, Southern Province of Zambia was identified for data collection. Southern Province of Zambia divided in to 13 districts. Out of 13 districts of the Southern Province, two districts namely Choma and Mazabuka were identified for data collection on harvest and post-harvest losses of meat and milk. Some details of these districts are given below:

Choma

Choma is situated on the way from Lusaka to Livingstone in the Southern Province. It is the capital of the Southern Province of Zambia. The temperature ranges between 14 °C and 28 °C. The highest temperature occurs between the beginnings of October to end of December. The lowest temperatures are usually recorded in June and July and sunshine ranges between 9 and 12 hours per day. The temperature comes down on starting of the rains. It starts generally from middle of October and end in the beginning of April. January is the peak of rainfall and slightly comes down up to the beginning of April when it usually ends. Choma has an average rainfall of 800 mm. Rainfall and its patterns vary from year to year. These variations can have a major impact on crop yield. Humidity falls to about 33 percent until the onset of rains in October after which it skyrockets to about 77 percent in February. The wind is predominantly from the east and south-west, and to a lesser degree from the northeast.

Mazabuka

Mazabuka is a district in Southern Province of Zambia. It is located about 160km from Lusaka. The climate of Mazabuka is warm and temperate. The average annual temperature is 20.9 °C. The rainfall is more in summers than winter and annual precipitation is about 780 mm.

1.5 Agricultural and livestock situation in Zambia

Agriculture is the major occupation in most of the provinces in Zambia. Maize, mixed beans, rice, sorghum, soybeans, sunflower, sweet potatoes, and wheat are the major crops in the provinces.

The livestock sector is worth over USD 1 500 million in Zambia and accounts for around 35 percent of agriculture production share of national gross domestic product (GDP). The sector has experienced steady growth in recent years. Beef and dairy products are growing around 7 percent and 10 percent annually respectively. The poultry industry has also doubled in size over the last ten years.

Table 1: Distribution of Types of Livestock by Province (2017)

Provinces	Cattle (%)	Goat (%)	Sheep (%)	Pig (%)
Central	22.6	16.8	18	10.2
Copperbelt	2.7	4.7	8.5	10.5
Eastern	16.4	10.2	18.4	28.3
Luapula	0.3	4.7	1.2	1.9
Lusaka	4.6	9.3	10.8	9.8
Muchinga	2.3	4.4	2.3	5.5
Northern	1.3	6.1	2.3	4.5
North Western	2.6	6.4	3.3	4.9
Southern	35.4	35.5	35	16.8
Western	11.7	1.9	0.1	8.3
Zambia	100	100	100	100

Table 1 shows the distribution of selected livestock i.e. cattle, goats, sheep and pigs that were raised as at census date. The cattle population (both household and establishment) as at census was 3 654 668¹, of which Southern Province accounts for the highest percentage, at 35.4 percent of the total national stock. Luapula Province accounts for the lowest percentage of cattle population at 0.3 percent of the total national stock. The goat population as at census was 3 476 790 of which Southern Province accounted for the highest population at 35.5 percent of the total national goat stock, followed by central province at 16.8 percent. Western Province accounted for the lowest percentage of goats' population at 1.9 percent of the total national stock. The sheep population as at census was 165 243 of which Southern Province accounts for the highest population at 35 percent of the total national sheep stock. Western Province accounts for the lowest percentage of sheep population at 0.1 percent of the total national stock. The table further shows that the population of pigs as at census was at 9 96 390 and Eastern Province records the highest of this national pig population at 28.3 percent. Southern and Copper belt provinces accounted for 16.8 percent and 10.5 percent, respectively. The province that records the lowest pig population was Luapula province at 1.9 percent of the total national stock.

2. Survey methodology

This section provides the details of the survey work undertaken in Zambia as well as the sampling details relating to field testing in the context of the estimation of harvest and post-harvest losses of meat and milk in Zambia.

2.1 Questionnaires used in the study

Questionnaires were developed for data collection and pre-tested in the identified study area of the country to examine the suitability and subsequently modify if required. The CAPI version of these questionnaires were developed.

Questionnaire 1: Listing of sampling units at different levels of sampling for estimation of harvest and post-harvest of livestock products (meat and milk) at on-site and off-site level

Listing of on-site producers of meat and milk and off-site marketing channels like wholesaler, retailers, processing units, cold storages, etc. of meat and milk was done using this questionnaire.

Questionnaire 2: On-site losses of meat during different operations at producers' level by enquiry and actual measurement

Data on meat loss at different operations (slaughtering, transportation, storage) were collected from selected slaughterhouses, wholesaler, and retailer by enquiry as well as actual measurement. A new questionnaire was used for each selected ultimate sampling unit. The data was recorded in the tables related to the particular entity.

Questionnaire 3: Off-site losses of meat during different operations at market level by enquiry and actual measurement

Data on meat loss at different operations (packaging, transportation, storages) were collected from selected meat cold storages / large storage and meat processing units by enquiry as well as actual measurement. Loss during packaging were observed only at processing unit. A new questionnaire was

¹ Zambia Statistics Agency (ZamStat): The 2017–2018 Livestock and Aquaculture Sample Census covered all household populations in both rural and urban areas of *Zambia* in the sampled areas.

used for each selected ultimate sampling unit. The data was recorded in the tables related to the particular entity.

Questionnaire 4: On-site losses of milk during different operations at producer level by enquiry and actual measurement

Data on milk loss at different operations (milking, packaging, transportation, storages) was collected from selected households having animals in milk and commercial dairy farms by enquiry and actual measurement. A new questionnaire was used for each selected ultimate sampling unit. The data was recorded in the tables related to the particular entity.

Questionnaire 5: Off-site losses of milk during different operations at market level by enquiry and actual measurement

Data on milk loss at different operations (packaging, transportation, storages) was collected from selected big collection center / milk chilling center, processing unit, wholesale milk supplier, retail milk seller and small milk collection center / milkman by enquiry and actual measurement. A new questionnaire was used for each selected ultimate sampling unit. The data was recorded in the tables related to the particular entity.

2.2 Training imparted

The training for data collection was imparted to the enumerators, supervisors, and officials of CSO and Ministry of Agriculture. The training was conducted in Mazabuka, a southern district of Zambia, by Dr. Tauqueer Ahmad and Dr. Anil Rai of ICAR-IASRI. The classroom training focused on concepts and definitions, sampling methodology, sample size and method of data collection from all the selected entities i.e. slaughterhouses, retailers, cold storage of meat and commercial dairy farms, households having milking animals, collection centers, retailers, chilling center, and processing units. Four enumerators and two supervisors attended the training for collecting data on harvest and post-harvest losses of meat and milk in both the districts. In each identified district, two enumerators were assigned for data collection. The data was collected using CAPI, a Survey Solution Software, therefore, CAPI version of questionnaires and hands-on training for filling-in CAPI version of the questionnaires were also provided.

For the field training, Mazabuka town was identified. First, the field exercise was carried out for data collection for measuring harvest and post-harvest losses of meat at slaughterhouse / abattoir and meat retail shop / butchery followed by measuring harvest and post-harvest losses of milk at Milk chilling centre and Commercial dairy farm. Questionnaires were pre-tested in the field using Tablets. Harvest and post-harvest losses at on-site i.e. producer level in case of meat and losses at on-site as well as off-site level in case of milk were recorded by inquiry method by the enumerators using Tablets. The doubts were clarified as and when required during the process of testing the questionnaires. In Zambia, the supply chain is short for meat. There are only two channels / entities i.e. slaughterhouses and retail meat shops. The different operations available at both the channels / entities are slaughtering, transportation and storage. Data on the quantity handled and lost along with other information was recorded for both meat and milk.

Classroom training and field training at commercial dairy farm



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Class room training

Field training at commercial dairy farm

The required sample size was decided for each channel for both meat and milk for this pilot. In case of meat, the sample size suggested for slaughterhouses was 2 per district i.e. four slaughterhouses for two identified districts for both inquiry and actual measurement. Sample size suggested for retailers was 20 per district i.e. 40 retailers for two identified districts for inquiry and eight per district i.e. 16 retailers for two identified districts for actual measurement.

In case of milk, the sample size suggested for milk producing households was 40 per district i.e. 80 households for two identified districts for inquiry and 16 per district i.e. 32 households for two identified districts for actual measurement. Sample size suggested for Commercial dairy farm (CDF) was two per district i.e. 4 CDFs for two identified districts for both inquiry and actual measurement. For off-site, the sample size suggested for milk collection centre was two per district i.e. four milk collection centers for two identified districts for both inquiry and actual measurement. Sample size suggested for retail milk sellers was ten per district i.e. 20 retail milk sellers for two identified districts for inquiry and eight retail milk sellers for two identified districts for actual measurement.

The listing of producers, CDFs and retailers in the case of milk and slaughterhouses and retailers in the case of meat was done by CSO for both meat and milk and were discussed in detail. After discussion, the list of retailers in case of both meat and milk needed to be updated and listing of households and Milk Collection Centers in case of milk and slaughterhouses in case of meat needed to be prepared. The updating of listing was done by the enumerators as per the recommendation.

During the training, a number of clarifications were sought on pre-harvest, harvest, post-harvest loss, live animal, carcass, quantity handled, on-site loss, off-site loss, causes of losses, weather parameters, units of measurement, among others, for which modifications in questionnaires were required. Necessary modifications were made after pre-testing the questionnaires (including the CAPI versions) before initiating data collection. Major corrections were made: Deletion of the question on live animal weight, inclusion of the address of slaughterhouses, adjustment of the question on food loss during the past week to per day followed by multiplication by seven days.

After discussion, the data collection plan for two identified districts was finalized. The date of start of the survey was 1 October 2018 and the survey completion was planned by 10 October 2018.

Field training at retail meat shop and feedback session



Field training at retail meat shop



Feedback and question-answer session

©ICAR-IASRI

Supervision of data collection work

The data collection work was supervised by Mr. Daniel Daka from CSO, Mr. Derrick Sikombe from Ministry of Agriculture and Dr Man Singh (Chief field Officer for ICAR-IASRI). The training program was over on 27 September 2018 and supervision work done by ICAR-IASRI from 30 September 2018 to 03 October 2018.

During supervision visits, the selection of sampling units was done using an updated list of entities that was provided to all the four enumerators. The data on post-harvest losses of meat and milk was collected in both the districts. In each identified district, two enumerators were engaged in data collection.

The supervision work was done in the Veterinary Camp (equivalent to village) named Mbabala of Choma district where two households for milk production were interviewed by the enumerator, one for data collection by enquiry and other for both enquiry and actual measurement. The household retained a small quantity of milk for their own consumption. There was no storage of excess quantity of milk at household level and no transportation of milk from milking place to home or on-farm storage. The milk was transported by the household from the milking place to a small milk collection centre / farmer's cooperative milk collection center for sale. Collecting the milk loss during transportation was not feasible by actual measurement, as following the household was challenging. The data was entered in the CAPI questionnaire.

Additionally, the data collection was supervised in one slaughterhouse, "The Real Meat Africa Co. Ltd" in Choma district where data on meat losses during slaughtering, transportation and storage was collected by enquiry. The animal-wise record of live weight of the animal and its corresponding weight of carcass was available in the record for each of the slaughtering days. There was no storage of meat. The slaughtered meat was transported to Lusaka for its sale. Transportation losses at slaughterhouse by actual measurement was not applicable.

In Mazabuka, data collection of two other enumerators was supervised. In Veterinary Camp Ngwezi "B" of Magoye block, one household for milk production was interviewed for data collection by enquiry and actual measurement. The data on food losses was collected on milking, transportation, and storage by enquiry and by actual measurement. There was no storage of milk at household level. There was no transportation of milk from the milking place other on-farm places. The milk was transported by the household from the milking place to a small milk collection center / farmer's cooperative milk for sale. Data collection was supervised for one meat retailer shop in Mazabuka central camp of Munenga block

of Mazabuka district where data on meat loss during transportation and storage was collected and recorded by enquiry.

Physical milk measurement and discussion with nodal officer



All photos: ©ICAR-IASRI

2.3 Control of non-sampling errors

Data quality is an important consideration in all surveys including agricultural surveys. Data quality is maintained by providing extensive training to the enumerators / supervisors. Further, supervision of fieldwork was carried out by ICAR-IASRI, CSO and Ministry of Agriculture to keep the data quality intact. The data was captured electronically to monitor the progress of data collection and data quality. Furthermore, the use of CAPI software reduced the data entry errors as well as minimized the data collection errors. The objective measurement, or actual measurement, was adopted to measure the losses on a sub-sample of the selected sample to improve data quality by statistical pooling.

2.4 Sampling and data collection

Sampling frame and sample size

The study was carried out in two districts. Listing was realized of entities: i) CDF in the case of milk, ii) slaughterhouses and retail meat shops, iii) retail milk sellers and milk collection centers. Listing of households in the selected Veterinary Camps in the case of milk was already done by CSO for all identified blocks, which was used to select the samples. Two districts, namely Choma and Mazabuka, were

identified for primary data collection. Four Veterinary Camps out of 12 in Mazabuka and four Veterinary Camps out of nine in Choma were selected randomly by Simple random sampling without replacement (SRSWOR).

In the case of milk, ten households were selected from each selected Veterinary Camp by SRSWOR i.e. 40 households for data collection by inquiry and 16 households for data collection by actual measurement. Additionally, two Commercial dairy farms were selected randomly from each district for recording data by both inquiry and actual measurement. At off-site, ten milk retailers were selected randomly from each district for data collection by inquiry and four retailers for data collection by actual measurement.

For on-site meat, two slaughterhouses were selected randomly from each district for recording data by both inquiry and actual measurement. For off-site meat, five retailers were selected randomly from each selected Veterinary Camp for data collection by inquiry and two retailers for data collection by actual measurement. In each district four Veterinary Camps were selected.

Sampling design

For this study, and in view of the administrative structure of the country, the sampling design used for selection of the sample for milking, transportation and storage operations at household level is a two stage sampling treating Veterinary Camps in the district as first stage units and households in the selected Veterinary Camps as second stage units. This allows obtaining district level on-site estimates. Whereas for milking operation at Commercial dairy farm level, a uni-stage sampling was used.

For obtaining district level off-site estimates in case of milk, the sampling design used for selection of sample for transportation and storage operations at Milk Collection Centre and retail level is uni-stage sampling i.e. by SRSWOR.

In case of meat, the sampling design used to select the sample for slaughterhouses is a uni-stage sampling i.e. SRSWOR, whereas for retailers it is two stage sampling treating Veterinary Camps in the district as first stage units and retailers in the selected Veterinary Camps as second stage units.

In the case of implementation of the methodology at national level, the sampling design suggested may be modified as per administrative structure of the country, size, and geographical dispersion of the sample units. In the case of milking by household, the sampling design suggested for obtaining national level estimates of food losses is a stratified three stage sampling treating Provinces as strata, districts as first stage units, Veterinary Camps in the selected districts as second stage units and households in the selected Veterinary Camps as third stage or ultimate stage units. Whereas for Commercial dairy farms, it is a stratified two stage sampling treating Provinces as strata, districts as first stage units and Commercial dairy farms in the selected districts as second stage units. For obtaining district level off-site estimates in case of milk, the sampling design used to select the sample for Milk Collection Centre and retailers is a stratified two stage sampling treating Provinces as strata, districts as first stage units and Milk Collection Centre / retailers in the selected districts as second stage units.

In case of meat, the sampling design used to select the sample for slaughterhouses is a stratified two stage sampling treating Provinces as strata, districts as first stage units and slaughterhouses in the selected districts as second stage units. Whereas for retailers it is stratified three stage sampling treating Provinces as strata, districts as first stage units, Veterinary Camps in the selected districts as second stage units and retailers in the selected Veterinary Camps as third stage or ultimate stage units.

Estimation procedure

The estimation procedure used as per the proposed sampling design was adopted for the feasibility of the study. The detailed estimation procedures are given in the guidelines for the countries to adopt in general.

But, in the case of Zambia, the estimation procedures as per the proposed sampling design mentioned in section 2.4.2 needs to be used for obtaining estimates at national level. Estimation procedures in the case of Zambia for both meat and milk are given in Annex of the meat and milk post-harvest loss estimation guideline.

Description of data collection

The data collection work was done with the help of four interviewers / enumerators and one supervisor and was divided in two groups namely on-site i.e. producer level and off-site i.e. distribution and market level. At on-site, the data collected was on harvest and post-harvest losses during milking / slaughtering, collection / packing, on-site transportation, while at off-site level the data was collected at transportation, storage, and processing.

Methods of data collection

The questionnaires were designed for data collection by CAPI methods. The operational manual was prepared for data collection for the benefit of field enumerators. Training of supervisors and enumerators identified for data collection was imparted ICAR-IASRI. The CSO, having expertise in the area of agricultural statistics in Zambia, was identified as the nodal agency for data collection. The data was collected by enquiry and actual measurement methods. Actual measurement method was used for data collection for a sub-sample of those selected for data collection by enquiry. Measuring scales were used for actual measurement for both meat and milk. However, data collection by actual measurement was limited to enquiry only in meat, because enumerators were not allowed to cut off 10 kg samples of meat in slaughterhouses as the carcasses were to be sent as a whole for next stage of processing.

Period of data collection

The data on harvest and post-harvest losses on meat and milk was collected during the period 1 October 2018 to 15 October 2018.

3. Results of Field Test in Zambia

This section provides the details of the results of field-testing to estimate harvest and post-harvest losses of meat and milk in Zambia.

3.1 Results and discussion

Table 2 provides pooled estimates of percentage loss (%loss) by enquiry and actual measurements under different on-site operations viz. milking / harvesting, transportation from farm to storage at producer level and total loss at producer level in case of milk (by households and Commercial dairy farms) in Choma and Mazabuka districts of Southern Province. The table also provides weighted estimates of both the districts along with standard error (SE of %loss) and a coefficient of variation (%CV of %loss) under each operation.

It can be seen that estimates of loss percentages during milking / harvesting, transportation from farm to storage at producer level (household) and total losses at producer (household) level in both districts are 6.35 percent, 1.75 percent and 13.97 percent respectively with 21.53 percent, 44.17 percent and 19.42 percent CV. In the case of Commercial dairy farms, it can be seen that estimates of percentage losses during milking / harvesting, transportation from farm to on-farm storage and total on-farm losses of milk in both the districts are 0.48 percent, 0.34 percent and 0.82 percent respectively with 32.89 percent, 10.87 percent and 20.11 percent CV.

Table 2: Estimates of percentage loss under different on-site operations by the milk producers

Statistics	By households			By Commercial dairy farms		
	Milking	Transportation from farm to storage at producer level	Total loss (Milking + Transportation at producer level)	Milking	Transportation from farm to storage at producer level	Total loss (Milking + Transportation at producer level)
Choma District						
% loss	2.15	0.98	3.13	0.56	0.34	0.90
SE of %loss	0.96	0.76	1.23	0.21	0.04	0.21
%CV of %loss	44.76	77.86	39.22	36.67	10.87	23.75
Mazabuka District						
% loss	13.33	3.03	16.36	0.36	-	0.36
SE of %loss	3.27	1.62	3.65	0.25	-	0.25
%CV of %loss	24.53	53.50	22.31	70.18	-	70.18
Weighted estimate of both the districts						
% loss	6.35	1.75	8.10	0.48	0.34	0.82
SE of %loss	1.37	0.77	1.57	0.16	0.04	0.16
%CV of %loss	21.53	44.17	19.42	32.89	10.87	20.11

Table 3 provides pooled estimates of percentage losses by enquiry and actual measurements of different off-site operations of milk in Choma and Mazabuka districts of Southern Province and weighted estimates of both the districts along with standard error and %CV of estimates of loss percentages by operation. This table shows that the estimates of %loss during packaging, transportation, and total loss for milk collection centres in both the districts are 0.04 percent, 0 percent and 0.04 percent respectively with 13.24 percent, N.A. and 13.42 percent CV. In case of retailers, the estimates of percentage loss during packaging, transportation, and total losses in both the districts are 1.60 percent, 0.59 percent and 2.19 percent respectively with 26.02 percent, 18.07 percent and 19.82 percent CV.

Table 3: Estimates of percentage loss under different off-site operations for milk

Statistics	By Collection centres/Chilling centres			By retailers		
	Packaging	Transportation	Total loss	Packaging	Transportation	Total loss
Choma District						
% loss	0.04	-	0.04	1.77	0.59	2.36
SE of %loss	0.00	-	0.00	0.54	0.03	0.54
%CV of %loss	13.24	-	13.24	30.63	5.11	22.92
Mazabuka District						
% loss	-	-	-	1.31	0.58	1.89
SE of %loss	-	-	-	0.64	0.28	0.70
%CV of %loss	-	-	-	49.02	47.92	36.96
Weighted estimate of both the districts						
% loss	0.04	-	0.04	1.60	0.59	2.19
SE of %loss	0.00	-	0.00	0.42	0.11	0.43
%CV of %loss	13.24	-	13.24	26.02	18.07	19.82

Table 4: Estimates of percentage loss due to storage under different on-site and off-site operations for milk

Statistics	Storage at producer level by households	Storage by collection centres/chilling centres	Storage by Retailers
Choma District			
% loss	3.69	3.60	0.44
SE of %loss	1.73	0.35	0.15
%CV of %loss	47.02	9.79	34.84
Mazabuka District			
% loss	-	0.54	1.47
SE of %loss	-	0.00	0.33
%CV of %loss	-	0.17	22.58
Weighted estimate of both the districts			
% loss	3.69	2.45	0.82
SE of %loss	1.73	0.22	0.16
%CV of %loss	47.02	8.98	19.01

Table 5: Estimates of percentage storage or retention of Milk in different channels in India (Nanda *et al.*, 2012)

Commodity	Retained by producer	Stored in collection centres / chilling centres	Retailer level storage	Total
Milk	29.73	46.61	23.67	100

Table 6 provides the overall total % milk loss at on-site, off-site, and storage loss in case of milk in both districts. Storage loss at different channels viz. households, milk collection centres and retailers have been obtained using retention percentage at these three channels utilized in Indian study (Nanda *et al.*, 2012) given in Table 5. This pilot did not allow to estimate retention figures for Zambia and therefore the data from India has been used as proxy.

It can be seen from the table that estimates of %loss during on-site, off-site, storage and total loss in case of milk in both the districts are 8.92 percent, 2.23 percent, 2.43 percent and 13.28 percent respectively with 17.69 percent, 19.28 percent, 15.02 percent and 12.34 percent CV.

Table 6: Estimates of total percentage loss under different on-site and off-site operations for milk using weighted estimates

Statistics		% loss	SE of %loss	%CV of %loss
On-site loss	By households	8.1	1.57	19.42
	By commercial dairy farms	0.82	0.16	20.11
	Total on-site loss	8.92	1.58	17.69
Off-site loss	By collection centres / chilling centres	0.04	0	13.24
	By retailers	2.19	0.43	19.82
	Total off-site loss	2.23	0.43	19.28
Storage loss	By households	3.69	1.73	47.02
	By collection centres / chilling centres	2.45	0.22	8.98
	By retailers	0.82	0.16	19.01
	Total storage loss*	2.43	0.37	15.02

Note: *- Using retention percentage formulae.

Table 7, 8 and 9 present the food loss estimates obtained for meat at slaughterhouses and at retail level. Estimates of percentage losses during slaughtering, transportation to storage at the slaughterhouse and total loss at slaughterhouses in case of meat in both the districts are 0.97 percent, 0.77 percent and 1.74 percent respectively with 38.75 percent, 28.89 percent and 25.24 percent CV. In case of retailers, it can be seen that estimates of percentage losses during slaughtering, transportation to storage and total meat losses in both districts are 1.71 percent, 0.54 percent and 2.25 percent respectively with 22.86 percent, 7.87 percent and 17.42 percent CV.

Table 7: Estimates of percentage loss under different on-site operations by the meat producers

Statistics	By slaughter houses			By retailers		
	Slaughtering	Transportation at producer level	Total loss	Slaughtering	Transportation at producer level	Total loss
Choma District						
% loss	1.54	0.77	2.31	1.95	0.85	2.80
SE of %loss	0.60	0.22	0.64	0.61	0.07	0.61
%CV of %loss	39.07	28.89	27.67	31.19	7.95	21.93
Mazabuka District						
% loss	0.02	-	0.02	1.31	0.02	1.33
SE of %loss	0.01	-	0.01	0.24	0.01	0.24
%CV of %loss	33.95	-	33.95	18.28	35.72	18.06
Weighted estimate of both the districts						
% loss	0.97	0.77	1.74	1.71	0.54	2.25
SE of %loss	0.38	0.22	0.44	0.39	0.04	0.39
%CV of %loss	38.75	28.89	25.24	22.86	7.87	17.42

Table 8: Estimates of percentage loss due to storage under different on-site operations for meat

Statistics	Storage by Slaughterhouses	Storage by Retailers
Choma District		
% loss estimates	2.82	3.79
SE of %loss	0.17	0.18
%CV of %loss	6.05	4.83
Mazabuka District		
% loss estimates	-	0.71
SE of %loss	-	0.15
%CV of %loss	-	20.55
Weighted estimate of both the districts		
% loss estimates	2.82	2.63
SE of %loss	0.17	0.13
%CV of %loss	6.05	4.81

Table 9: Estimates of percentage storage or retention of meat in different channels in India (Nanda et al., 2012)

Commodity	Retained by producer	Retailer level storage	Total
Meat	1.94	98.06	100

Table 10: Estimates of total percentage loss under different on-site operations for meat using weighted estimates

Statistics	Total loss by slaughter-houses	Total loss by retailers	Total meat loss	Storage by slaughter-houses	Storage by Retailers	Total storage loss
% loss	1.74	2.25	3.99	3.69	2.45	2.63
SE of %loss	0.44	0.39	0.59	1.73	0.22	0.13
%CV of %loss	25.24	17.42	14.74	47.02	8.98	4.84

Note: *- Using retention percentage formulae.

Table 10 provides the overall total percentage loss table, storage, and total loss in case of meat in both districts. Storage loss at different channels viz. slaughter houses and retailers have been obtained using retention percentage at these two channels utilized in Indian study (Nanda *et al.*, 2012) given in Table 9.

It can be seen from the table that estimates of percentage loss during on-site, storage and total meat loss in both districts are 3.99 percent, 2.63 percent and 6.62 percent respectively with 14.74 percent, 4.84 percent and 9.08 percent.

3.2 Challenges encountered

- **Losses in the context of Zambia:** The field exercise allowed observing the different actors that participate in the supply chain of milk and meat. In case of losses in milk at household level, in some cases in Mazabuka district, 100 percent loss were observed which was due to the animal infected with disease. The data analysis including these observations in the sample showed 29 percent loss at household level in Mazabuka district, in comparison to the 2.15 percent loss at household level in Choma district. This raised the conclusion that the loss related to an animal infected with disease should be considered as pre-harvest loss.
- Successful completion of various activities within the pilot period was a challenge.

3.3 Lessons learnt

- **Losses in the context of Zambia:** In case of milk losses at household level, in some cases in Mazabuka district in which 100 percent loss was observed due to the animal infected with disease, the data was redefined (here as pre-harvest loss) ignoring such 4 observations out of 40 observations in the sample in Mazabuka district. Redefinition showed 13.33 percent loss at household level in comparison to the 29 percent loss obtained earlier. This field experience conveys that such a loss which is not a regular feature and is a rare occurrence in a season / year, may not be considered as loss as this type of loss may be categorized as pre-harvest loss (disease to the animal before milking).
- **CAPI based data collection:** There is significant time saving in data entry and data cleaning due to CAPI based data collection, which is cost effective. Therefore, it is advisable for the countries to use CAPI for such surveys. To use CAPI technology, it would be essential that there is capacity building in executing the survey.
- **Operational definitions and questionnaires:** Field testing experience in Zambia for meat and milk shows that the concepts and definitions, questionnaires developed in the guidelines are working fine and applicable in the countries with limited customization of questionnaires as per administrative structure of the country. Actual measurement at slaughterhouses might be adjusted to observe the process of one sampled live animal instead of 10kg of sample meat.
- **Stages and operations / channels:** Wholesalers in case of the meat and milk supply chain in Zambia are not a common stage, where the produce is directly sold to retailers. Retailers conduct slaughtering and sell the slaughtered animals at their retail shops, wherefore they integrate these stages.
- **Sampling design, sample size and estimation procedures:** Sampling designs developed for different operations / channels are applicable / adoptable to other countries. However, these need customization as per administrative structure of the country. For Zambia, the sampling designs applicable for the feasibility of this study are simpler and customized. In general terms, the sample size was acceptable as %CV of the estimate of %loss for two districts in case of milk at on-site, off-site, storage and overall are 17.69, 19.28, 15.02 and **12.34** respectively. In the case of meat, storage and overall meat loss estimates are 14.74, 4.84 and **9.08** respectively, which shows that the developed sampling methodology for estimating harvest and post-harvest losses of meat and milk will provide more or less reliable estimates at Province level and National level.

Conclusions

Field-testing of the developed guidelines for estimating harvest and post-harvest losses of meat and milk was conducted in Zambia. The meat and milk concepts and definitions of post-harvest losses, the questionnaires and CAPI versions of the questionnaires, the sampling design and sample size, and estimation procedures was field tested during the period 1 October 2018 to 15 October 2018. Field test results shows that the estimate of percentage losses for two districts namely Choma and Mazabuka **in case of milk** at on-site, off-site, storage and overall are 8.92, 2.23, 2.43 and **13.58** with %CV as 17.69, 19.28, 15.02 and **12.34** respectively. **In case of meat**, the estimate of the percentage loss at on-site, storage and overall are 3.99, 2.63 and **6.62** with %CV as 14.74, 4.84 and **9.08** respectively which implies that **the developed sampling methodology for estimating harvest and post-harvest losses of meat and milk will provide reliable estimate at Province level and National level**. It is important to conduct value chain analysis before conducting the actual survey.

It is also concluded that the **sample size for this feasibility study is also adequate** as %CV of the estimate of percentage losses for two districts in case of both meat and milk are within acceptable limit. **Sampling designs developed for different operations / channels in case of both meat and milk are applicable / adoptable in other countries**. However, **it needs customization as per administrative structure of the country**. In case of Zambia, the sampling designs applicable for this study are simpler and customized. It is also concluded that **it is advisable for the countries to use CAPI for such surveys** as there is significant time saving in data entry and data cleaning when using this method. Besides, it is more cost effective than paper-based surveys.

References

Nanda, S. K., Vishwakarma, R. K., Bathla, H.V.L. and Anil R. 2012. *Harvest and Post Harvest Losses of major crops and livestock produce in India*. All India Coordinated Research Project on Post Harvest Technology (ICAR), Ludhiana.

Guidelines on the measurement of harvest and post-harvest losses

Estimating harvest and post-harvest losses in Zambia

Meat and milk

FIELD TEST REPORT

This technical report provides findings of a field test conducted in identified districts / study area in Zambia on the basis of sampling methodology for estimation of harvest and post-harvest losses of animal products (meat and milk) developed by the team led by Dr. Tauqueer Ahmad, Head, Division of Sample Surveys, Indian Agricultural Statistics Research Institute, Institute of Indian Council of Agricultural Research (ICAR-IASRI), New Delhi, India. The Technical Report entitled “Findings from the field test conducted on estimating harvest and post-harvest losses in Zambia. Meat and milk.” contains details of findings of the developed methodology implemented in Zambia including challenges encountered and lessons learnt. It is expected that this report will help the users from different countries in designing surveys for measurement of harvest and post-harvest losses of animal products (meat and milk).