



Instrument Grading Systems for Ovine Carcasses

Performance Requirements for Instrument Cutability Evaluation *Demonstration of Accuracy and Precision*

BACKGROUND

The Department of Agriculture (USDA), Agricultural Marketing Service (AMS), Livestock and Seed (LS) Program will accept ovine carcass cutability measurements made by approved instruments. The LS Program will approve instrument systems that meet specific performance requirements for accuracy, and precision in the prediction of saleable meat yield of carcasses. The performance requirements outlined in this document were established after consultation with an Industry Working Group that was convened by the LS Program and the American Sheep Industry Association (ASI). The Industry Working Group was comprised of representatives of USDA, ASI, packing companies, producers, instrument manufacturers, and academia.

PURPOSE

The purpose of this document is to provide a performance standard to determine if instrument systems can objectively predict, accurately and precisely, percent ovine carcass cutability (OCC) yield. An instrument must be tested and must meet the following requirements to gain approval from the LS Program. The approval process consists of a demonstration of the accuracy and precision of percent OCC yield prediction at line speeds.

REFERENCE DOCUMENTS

Institutional Meat Purchase Specifications (IMPS) for Fresh Lamb and Mutton Series 200. United States Department of Agriculture, April 1996.

Standard Specification for Developing and Validating Prediction Equation(s) or Model(s) Used in Connection with Livestock, Meat, and Poultry Evaluation Device(s) or System(s) to Determine Value. ASTM International Standard F 2340-05.

Standard Test Method for Livestock, Meat, and Poultry Evaluation Devices. ASTM International Standard F 2343-06.

Standard Terminology for Livestock, Meat, and Poultry Evaluation Systems. ASTM International Standard F 2463-06.

METHODOLOGY

Carcass Imaging and Selection

An instrument system must be tested during four separate seasons to ensure variation due to lamb production seasonality is considered. Trial dates and lamb sources are to be determined by AMS. During each of the four trials, a target of 150 carcasses (Table 1) shall be included to adequately represent the U.S. lamb population and the full range of yield grades (i.e., each instrument presented for approval must be tested on 600 or more carcasses). Carcass weights should be reasonably distributed above and below

an average dressed carcass weight of 69.5 pounds (average dressed carcass weight for the years 2000-2009). If a company-specific user of an instrument system seeks approval for use only within their organization, the instrument system must also be tested as specified above.

Table 1. Minimum Number of Carcasses for Instrument Assessment

Yield	Number for On-line Grading per Trial (Phase II)
Yield Grade 1	22
Yield Grade 2	36
Yield Grade 3	43
Yield Grade 4	27
Yield Grade 5	22
Total	150

Carcasses must be presented for image capture and analysis at a continuous normal operating chain speed. The Yield Grade matrix shown in Table 1 will serve as the template in guiding carcass selection. Following carcass evaluation by the instrument, an AMS representative will ascertain USDA Yield Grade and another AMS representative will select carcasses to be included in the study. Selected carcasses will be placed in a holding cooler to obtain a 24-hour chill. Carcasses will then be segregated onto a stationary rail for the determination of cutability (percent closely trimmed subprimal cut yield) as described below.

Establishing Ovine Carcass Cutability Yield

In order to validate the accuracy and precision of an instrument system, the cutability must be established for each carcass selected for evaluation. Percent OCC yield must be evaluated by a method approved by LSSD. The carcass subprimal cuts that define percent OCC yield are listed in Table 2. Subprimal specifications shall closely approximate the Institutional Meat Purchase Specification (IMPS) description as described in the *Institutional Meat Purchase Specifications for Fresh Lamb and Mutton Series 200* (USDA, April 1996).

Table 2. Ovine Carcass Fabrication Schedule

IMPS Item No.	Name
204C	Rack, Roast Ready, Frenched PSO 3x1"
208	Shoulder, Square-Cut, Boneless, Tied
209	Breast
210	Foreshank
-	Neck
232A	Loin, Short-cut, Trimmed PSO 0x0"
232E	Flank, Untrimmed
233F	Leg, Hindshank
234A	Leg, Shank Off, Boneless, Tied

Carcasses are to be separated into foresaddles and hindsaddles, further separated into primal and finally, subprimal cuts. Subprimal/primal cuts are to be closely trimmed of external fat (0.25 in - 0.64 cm). Weights are to be recorded for all parts at each hierarchical step. The weights of the two saddles will be summed to determine chilled carcass weight. Carcasses shall be excluded from the trial if the total aggregate cut weight for each carcass is less than 98% of its' chilled carcass weight.

AMS will compute the percent OCC yield by calculating the percentage of the weight of closely trimmed subprimal/primal cuts to the chilled carcass weight. Carcasses will be sorted by percent OCC yield within season and lot number and then every third carcass will be assigned to the validation data set with the other two assigned to the calibration data set. AMS will provide the percent OCC yield, hot carcass weight, chilled carcass weight and all subprimal and associated cut weights to the technology provider for the carcasses assigned to the calibration data set. The technology provider may use the calibration data to develop or refine their percent OCC yield prediction equation.

Submission of Predicted Percent Ovine Carcass Cutability Yield and Prediction Equation

At the completion of the four trials, the technology provider will submit the instrument predicted percent OCC yields to AMS for comparison with the percent OCC yield of the validation data set. AMS will then compute the necessary statistics to determine if the instrument system meets the requirements below. The technology provider will provide AMS with a copy of the prediction equation used as well as the values for each variable in the prediction equation for each of the predicted percent OCC yields, which AMS will use to validate the information collected and outputs computed.

Exclusion of Images Captured and Data Collected

In order for the test to provide the best results possible, AMS will review all data and images to determine if the data and images from the selected carcasses were accurately obtained. Technology providers must submit to AMS the original image and the processed display screen image or thumbnail for each carcass in the test so that images can be reviewed to determine if proper image capture occurred.

PERFORMANCE REQUIREMENTS

Scope

Approval will be granted in accordance with the following performance requirements to an instrument system that predicts percent OCC yield accurately and precisely using instruments and devices that utilize a validated prediction equation. The scope of an instrument's approval is determined by AMS and will be based on the intended use of the instrument system. The scope will be set forth in the final approval.

On-line Measurement of Accuracy and Precision Performance Specifications

- Average residual = $0 \pm 2\%$ percent OCC yield units where the residual is the difference between the instrument percent OCC yield and the realized percent OCC yield;
- The standard deviation of the residuals (rSD) from the realized percent OCC yield $\leq 4\%$ realized percent OCC yield units; and,
- The prediction equation would be deemed valid if the root mean square error for validation is within 20 % of the root mean square error for calibration (see ASTM International Standard F 2340). The root mean square error for validation is defined by square root of the sum of squared residuals divided by n_y where n_y is the sample size for the validation data set. The root mean square error for calibration is defined by the square root of the sum of squared residuals divided by $n_c - (k + 1)$ where n_c is the sample size for the calibration data set, and k is the number of explanatory variables in the prediction equation.

ESTABLISHMENT IMPLEMENTATION APPROVAL PROCESS

Procedures for the implementation and verification of operational accuracy will be established and approved on a plant-by-plant basis once the instrument has met the performance requirements above. For

the minimum criteria that must be addressed, please review the LS Program document titled *Implementation and Verification of Operational Procedures*.

This standard is subject to revision at any time by the LS Program.

Requests for approval shall be submitted to:

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