7. Sampling Techniques

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Learning objectives

By the end of this lecture, you should be able to:

- Describe the reason grab and core samples are taken from wool bales
- Describe the equipment used for grab and core sampling wool bales
- Describe the key elements of the IWTO Test Methods for grab and core sampling wool bales
- Describe the procedure used to grab and core sample wool bales
- Understand the sampling factors that influence the precision of wool test results

Key terms and concepts

Grab sample, core sample, grab machine, grab jaw, core machine, pack slitter, grab schedule, core schedule, pack waste, yield, micron, staple length, staple strength, certification, show floor, appraisal.

Introduction to the topic

Figure 7.1 Sampling machine comprising a grab station on the right, bale weighing platform in the centre and core chamber on the left (mostly obscured by guarding)**.**
Source: AWTA, (2005).

This topic describes the techniques involved in obtaining samples from bales of wool. Samples are taken prior to wool being sold, generally using mechanical apparatus. Two types of samples are taken. Grab samples that are further sub sampled and tested to determine average staple length and strength and then go on to serve as samples for inspection by buyers. Core samples are taken and tested to determine yield and mean fibre diameter. Bale weights are recorded at the time of sampling. Sampling is conducted in accordance with methods determined by the International Wool Textile Organisation (IWTO). The use of standard sampling techniques allows test results to be certified which facilitates the international trade of Australian wool.

7.1 Grab sampling

Principal

Grab samples are taken to create a representative sample of a sale lot, comprising of one or more bales of wool of greasy wool, which may be used for the following purposes:

1. Further sub-sampling for the determination of average staple length and staple strength
2. The subjective appraisal of unmeasured characteristics, and
3. As a display sample for perusal by prospective buyers.

Grab samples are taken from sale lots using a mechanical grab apparatus. Grab samples are taken from each bale in a sale lot in such a way that every portion of wool in the sale lot has an equal chance of being selected and each bale within a sale lot is equally represented in the sample (Standards Australia 1984).

Equipment

Pack Slitter

Wool is generally packaged in bales made from synthetic material. Openings or slits are made from above through the surface of the bale to allow access for grab sampling. The openings are made using a pack slitter, which may be either:

1. A sharp knife or blade used to cut the pack material, or
2. A heated metal bar used to melt the synthetic pack material.

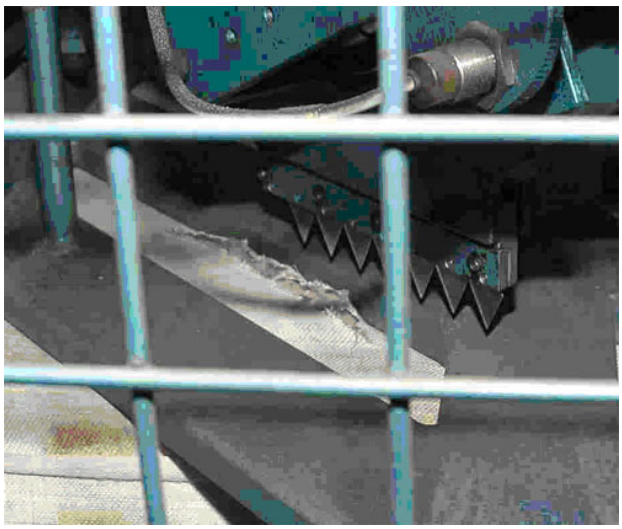

Figure 7.2 Pack slitter automatically cuts grab hole in pack with sharp blades**.**
Source: AWTA, (2005).

Grab machine

A set of hydraulically operated grab jaws that operate with a pincer action are mounted on a powerful hydraulic grab arm that moves vertically. The grab machine operates by driving the grab arm through the slit made in the pack material by the pack slitter and into the densely packed bale of wool. The grab jaws close, grasping a sample of wool, then the grab arm withdraws from the bale and the grab jaws open to release the sample. Grab machines may be automated or manually operated. They may have from one to nine grab arms.

Figure 7.3 Grab machine with bale in place ready for sampling. Source: AWTA, (2005).

Requirements

Grab samples must be taken at random, be consistent and the final sample must be representative of the sale lot. For this to occur, the following requirements must be met (IWTO 2004):

1. Each bale in a sale lot shall be sampled
2. The same number of grab samples shall be taken from each bale in a sale lot
3. The minimum number of grab samples taken is 20, although exceptions exist for particular types of small lots of three bales or less
4. All grab samples taken from the sale lot shall be of similar size
5. Not more than two grab samples shall be taken from any one slit
6. No grab sample of suitable size shall be excluded from the sample.

Procedure

1. The number of grab samples that are necessary is determined in accordance with the sampling requirements
2. Sampling positions are selected at random on the side of a bale in such a way that every portion of wool in the bale has an equal chance of being sampled. A suggested pattern is illustrated below where the side of a bale is broken up into nine sites. Since grabs can be taken at two depths, one shallow and the other deep, this effectively creates 18 equally sized sample sites within each bale
3. Each bale is presented for grab sampling lying on its side; the surface to be sampled is facing upwards
4. The appropriate number of slits are made in the upper surface of the bale using the pack slitter. Slits are made at an angle of 45° to the length of the bale and parallel to the grab jaws. Limiting the slit length contributes to the control of the grab sample size

5. The closed grab jaw is inserted through the slit
6. The grab arm penetrates the bale and the grab jaw opens during the final downward motion of the grab arm
7. The grab jaw closes, grasping a grab sample
8. The grab arm is withdrawn clear of the bale and the jaws open, depositing the grab sample for collection
9. If two grabs are to be taken from the same hole, the first will be shallow and the second deep
10. Individual grab samples are accumulated until the completion of sampling of the sale lot. The mass of each grab sample is approximately 250g and the final sample mass is approximately 5Kg
11. Upon completion, the grab sample may be further sub-sampled for staple length and strength testing
12. The completed grab sample is presented on a show floor for appraisal of unmeasured characteristics and perusal by buyers.

Figure 7.4 Grab sample ready for removal from grab jaws. Source: AWTA, (2005).

Figure 7.5 The appraisal of Grab samples on display on a show floor.
Source: AWTA, (2005).

4¤	7¤	2¤
1¤	9¤	5¤
6¤	3¤	8¤

Figure 7.6 Schematic of grab sampling sites on the side of a bale. Source: AWTA, (2005).

7.2 Core sampling

Principal

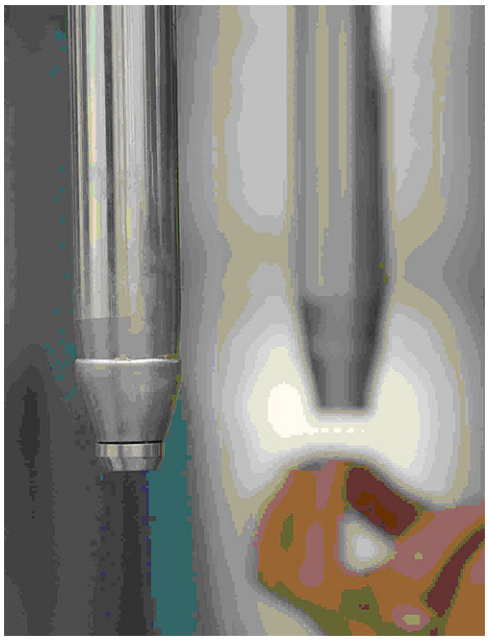

Figure 7.7 Changing the cutter tips on core tubes in a Core Machine.
Source: AWTA, (2005).

A Core Sample is a representative sample taken from a sale lot comprising of one or more bales of wool of greasy wool. Core sample material is tested to determine the yield and mean fibre diameter of the wool in the sale lot. Bales must be weighed at the same time that core samples are taken, and samples are sealed in airtight bags to prevent any change in the moisture content of the sample during the interval between sampling and testing. Core samples are usually taken using machines, although they can be taken using manual apparatus.

Equipment

Core Machine

A core machine has a coring chamber that encloses a bale during core sampling. The bale is presented in the chamber base uppermost. During core sampling a platen lifts the bale, compressing it against the top of the chamber. Hollow core tubes with removable sharpened tips or cutters are driven downwards through the base of the bale by hydraulic rams, penetrating almost the entire length of the bale. Flexible tubes connected to the core tubes evacuate the core sample material, depositing it in a plastic bag. A core machine may have multiple core tubes. The position of the core tubes can be varied.

Figure 7.8 Core sampling a bale, bale is compressed against the roof of the chamber, core tubes penetrate from above. Source: Steere (2006).

Requirements

1. Each bale in a sale lot is core sampled
2. A minimum of 20 cores are taken from a sale lot although exceptions exist for particular types of small lots of three bales or less.

The same number of core samples are taken from each bale in a sale lot. The number of core samples taken per bale is sufficient to produce a sampling precision of no worse than ± 1% IWTO Clean Wool Content at a probability level of 0.95.
The minimum number of cores to be taken per bale to produce a sample having the required precision may be estimated from the following formula:

$$K = \frac{(1.96\sigma_w)^2}{N}$$ Where:

K = minimum number of cores to be taken from each bale in the lot (round up to next highest whole number).
N = Number of bales in the lot.
σ_w = Standard deviation of Clean Wool Content of cores within bales, which is 2.0 for Australian Wool.

A review of the value of σ_w for various wool properties is given by Russell and Cottle (1993, also see Readings Russell and Cottle 1993.pdf). Students should read this paper to gain an understanding of the basis of current wool sampling schedules.

1. A minimum of 750 grams of sample material is required for testing. Extra cores may be taken if insufficient sample mass is obtained
2. The bales are weighed at the time of core sampling to ensure that no change in bale mass occurs between the operations of weighing and sampling
3. The position that the core sample is taken through the base of the bale is varied and no more than one core is taken from any one position
4. The core tube enters the bale in the direction of bale compression and parallel to the sides of the bale
5. The same depth of penetration is maintained for each bale within a lot and shall be at least 93% of the length of the bale
6. Following the initial penetration of the bale, the pack material is removed or ejected from the core sample to avoid contamination of the sample and wool within the bale.
7. The balance of the core material is retained and must correspond to at least 80% of the length of the bale.

Procedure

1. A suitable plastic sample bag is secured to the core collection point on the core machine
2. A bale is positioned in the coring chamber and the platen lifts the bale from below, compressing it to a fixed length against the top of the chamber
3. The correct number of cores per bale is determined in accordance with the sampling requirements
4. A core position is selected at random. Positions vary from bale to bale within a sale lot in accordance with the sampling requirements
5. The core tube starts to penetrate the bale and the initial plug of core sample material containing the pack material is ejected as core waste. The core tubes continue to penetrate to the required depth and the remaining core sample material is retained
6. The core sample material is evacuated through flexible hoses connected to the core tubes and is deposited into the plastic sample bag at the core collection point
7. The core tube withdraws and, if necessary, the next coring position is selected and another core sample is taken. Otherwise, the bale is ejected from the chamber and the next bale is loaded
8. Completed core samples are sealed and placed in a second plastic bag, which is also sealed. The double bagging of samples prevents any change in moisture content of the sample in the period between sampling and testing. This is important for the correct determination of yield.

Readings [3]

The following readings are available on web learning management systems

1. Australian Wool Testing Authority Ltd. (AWTA), 2002, Testing the Wool Clip.
2. Australian Wool Testing Authority Ltd. (AWTA), 2003, Classing using in-shed testing: Why do fine lines measure coarser than predicted?, AWTA Information sheet, February 2003.
3. Russell B.C. and Cottle D.J. 1993, Sampling variance in sale lots and its influence on test precision, *Wool Technology and Sheep Breeding,* vol. 41(2), pp. 127.

Summary

Summary Slides are available on web learning management systems
An established and well-considered system for obtaining representative grab and core samples from wool bales provides the confidence that is an integral part of the trading of Australian wool. It allows the trading of wool on the basis of certified test results and the perusal of a representative reference sample. Grab samples are taken for sub-sampling and testing for average staple length and strength testing, they then serve as display samples for appraisal by buyers. Bales are weighed and core samples taken for testing for the determination of yield and micron.

References

IWTO–38, 1999, Method for Grab Sampling Greasy Wool from Bales, International Wool Textile Organisation test method, Brussels.

IWTO, 2004, IWTO Regulations, International Wool Textile Organisation, Brussels.

Reading 3 - Russell B.C. and Cottle D.J. 1993, Sampling variance in sale lots and its influence on test precision, *Wool Technology and Sheep Breeding,* vol. 41(2), pp. 127.

Standards Australia, 1982, *Wool-Core Sampling of Raw Wool in Bales.*

Standards Australia ,1984, Wool-Grab Sampling of Greasy Wool.

Teasdale, D.C. 1988, Wool Testing and Marketing Handbook, University of NSW, Australia.

Glossary of terms

Baling surfaces	the two surfaces upon which the main baling pressure has been applied to a bale. This usually means the cap and base of a bale
Base (when referring to a wool bale)	the permanently closed end of a wool bale on which baling pressure is applied (also see cap)
Cap	the end of a wool bale on which baling pressure is applied, normally closed by pinned flaps but which may be opened for inspection of the contents (also see base)
Commercial yield	any of the yields, calculated from the Wool Base, Vegetable Matter Base and Hard Heads and Twigs Base as specified in Section 3.0 of the IWTO Core Test Regulations. Yields may be expressed either as net clean mass of a lot or delivery, or as the net clean mass expressed as a percentage of the net greasy mass
Core sample	a representative sample of raw wool obtained from each bale in the lot by coring techniques
Core test	the series of measurements, typically of Wool Base, Vegetable Matter Base and Mean Fibre Diameter, carried out on a core sample

Coring machine	equipment which uses hydraulic power to drive one or more pressure coring tubes into a bale of wool so that the tube reaches at least 93% of the length of the bale. Cores are automatically ejected from the tube
Coring tube	a tube of circular cross-section which is equipped with a sharpened, replaceable tip. The tip enables the tube to penetrate a bale of raw wool without rotation, remove a cylindrically-shaped portion of the wool and retain it without change in material or moisture content. When part of a coring machine, the coring tube must penetrate at least 93% of the length of the bale
Display box	an open box large enough to hold and display a grab sample of wool for appraisal and evaluation purposes
Display sample	the grab sample taken from a single lot when it is placed in a display box
Grab machine	a mechanical device capable of operating a set of jaws, which penetrate into the side of a wool bale and withdraw a representative grab sample of suitable mass. The jaws withdraw the entire sample in such a way as to avoid contamination of the wool by pack material, and to avoid damage to the pack
Grab sample	the greasy wool drawn from a bale by a single operation of a grab machine
Lot	any number of bales of wool, of similar mass and dimensions, prepared for sale as a single parcel in accordance with accepted trade practices
Mean fibre diameter	the arithmetic mean of all fibre diameter readings in a sample
Micron	commonly used name for the unit of measurement of fibre diameter, correctly termed a micrometre (μm)
Sale lot	a number of bales of similar mass and from the same country of origin, containing greasy wool prepared for sale according to accepted trade practices
Sample	the wool drawn by appropriate methods from a lot, bulk or delivery. In order to issue IWTO Test Certificates, the sample must be drawn in strict accordance with the relevant IWTO Test Regulations to ensure that it is representative
Staple length	the length of a staple projected along its axis obtained by measuring the staple without stretching or disturbing the crimp of the fibres
Staple strength	the maximum force required to rupture a staple per unit of average linear density
Yield	the amount of clean fibre, at a standard regain, that is expected to be produced when a delivery of raw wool is processed. The yield may be expressed both as a clean mass in kilograms and as a percentage of the mass of raw wool prior to processing