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The mission of the National Lucerne Trust (NLT) is to enable a sustainable, innovative, and profitable future for the South African lucerne hay and seed industry. It aims to bring this to fruition through:

- strategic investment in research and development;
- information and technology transfer;
- maintenance of quality control and certification systems; and
- transformation of previously disadvantaged persons.

Guide for the grading of lucerne hay, part 1

by Dr GDJ Scholtz and Prof. HJ van der Merwe, Lucerne TechConsult

To create an accurate and uniform grading system, it is imperative that all prescribed procedures regarding sampling, the handling of samples, identification of outliers, and quality standards be meticulously applied.

(Part 2 of the Guide will cover certification, interpretation of analyses, handling lucerne hay grading disputes, and the Lucerne TechConsult (LTC) hay probe in more detail.)

1. SAMPLING

The following procedure should be followed during sampling:

1.1 Identify a single lot of lucerne bales

Identify a homogeneous amount of lucerne bales of:

- the same cut;
- the same variety;
- the same farmland;
- the same physiological stage; and
- cut within a period of 48 hours.

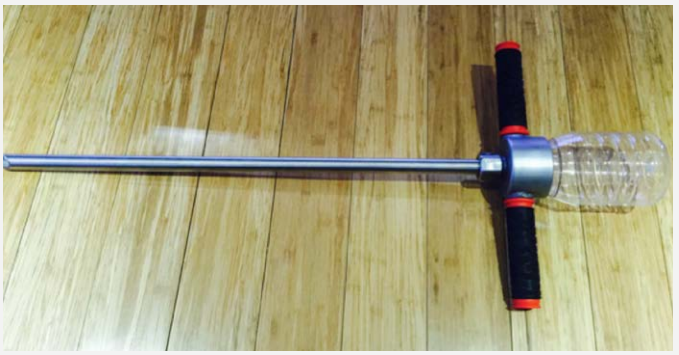
1.2 Sampling should be done randomly

This means that no predetermined reason such as colour or leafiness should exist for a particular bale to be selected.

1.3 Sampler/probe specifications

A standardised hollow core probe (Figure 1), as prescribed by the NLT, should be used to establish quick, easy, and representative sampling.

Figure 1: Prescribed lucerne hay probe



1.4 The correct drilling technique should be applied

- Insert the drill into the centre of the top side of the bale at 90° or in the centre of the side of a bale at an angle of 45°.
- The drill should be inserted at least 325 mm deep into the bale (as indicated on drill).
- The bit of the drill should be sharpened regularly.

1.5 Ample sub-samples should be taken, spread proportionately over the lot

- A minimum of 20 samples is needed to limit variation.

- Number of sub-samples per bale: small bales – one; large or round bales – two.

1.6 Sample size

- A sample of 180 to 250 g is useful.
- A sample less than 180 g is deemed to be non-representative.
- If a sample should exceed 250 g, handling during the mixing process would be impaired, because the entire sample must be mixed. If samples are found to be too large, the drill diameter is normally too large.

1.7 Handling of samples

- Sub-samples should be immediately combined, thoroughly mixed and sealed into air-tight bags for transporting to the nearest NLT-registered near-infrared (NIR) instrument.
- All samples should be protected against heat and direct sunlight.

1.8 Division of a sample

Under no circumstances should samples be sub-divided.

2. HANDLING OF SAMPLES

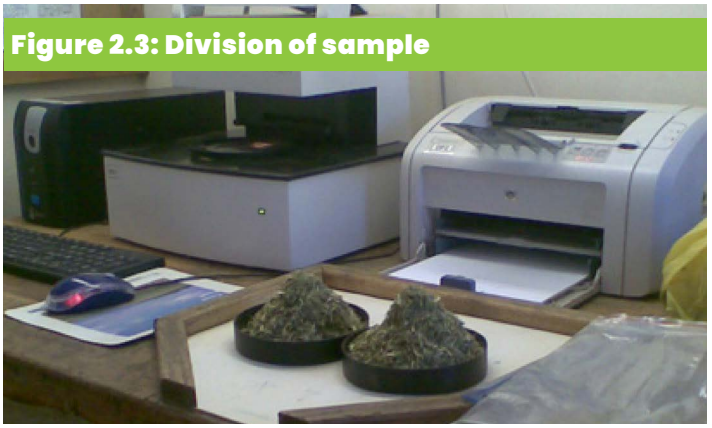
Perten DA 7200 instrument	
Figure 2.1: Grading equipment 	**STEP 1:** Equipment needed: collection bowl, plastic bag, scraper. Pour sample from collection bottle into plastic bag.
Figure 2.2: Mixing of sample 	**STEP 2:** Mix sample thoroughly in plastic bag.
Figure 2.3: Division of sample 	**STEP 3:** Divide sample equally between two bowls.

Figure 2.4: Levelling of sample

STEP 4:
To level, scrape bowls slightly with a ruler or flat object without compacting the sample.

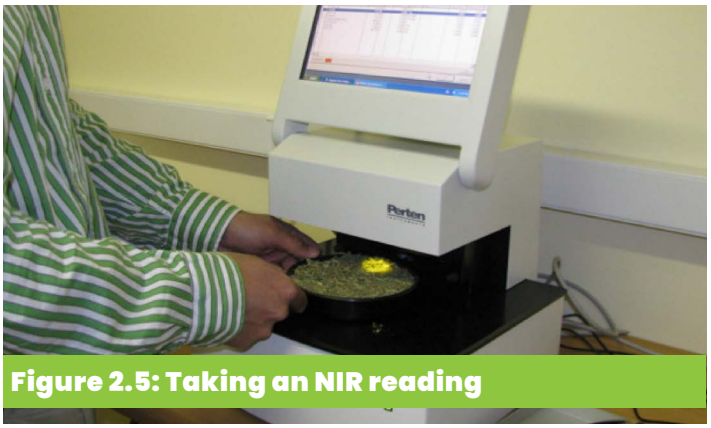


Figure 2.5: Taking an NIR reading

STEP 5:
Take readings from both bowls.

Figure 2.6: Repetition of process

STEP 6:
Pour contents of bowls and residue back into plastic bag and repeat Steps 1 to 4 to obtain average readings for four bowls.

Follow the link or QR code for a video on this topic:
https://youtu.be/SZPVaMuM9vQ?si=7pBC87JQhCmNBHwJ

3. IDENTIFYING OUTLIERS

It is very important that outliers be identified and those samples saved and presented to the NLT for further calibration development. The following process should be followed for the identification of outliers.

For the identification of outlier lucerne samples, a Perten DA 72XX Diode Array Based NIR Analysis System should be used. NIR technology can indicate whether or not samples presented to instruments will match the existing calibration being used. The Perten DA72XX makes use of Mahalanobis distances to indicate acceptable or unacceptable spectral matches against existing calibrations. Once an analysis has been completed, a sample is flagged under the "match" column as "yes", "possible" or "no".

"Yes" indicates:

- good spectral agreement with the calibration sample spectra according to the "limits" in the "Mahalanobis Distance/Leverage" setting (done upon installation);
- the component/parameter results are within the limits expected for the product; and
- the component/parameter results are within the limits set in the calibration model.

"Yes" results can be accepted as correct and can be used in conjunction with the NLT guidelines for grading of lucerne.

"Possible" indicates:

- fair spectral agreement with the calibration sample spectra according to the "limits" in the "Mahalanobis Distance/Leverage" setting.

"Possible" results should be reanalysed before official grading takes place. If a second "Possible" result is obtained, the sample should be retained for further calibration purposes.

"No" indicates:

- poor spectral agreement with the calibration sample spectra;
- the component/parameter results are outside the limits expected for the product; and/or
- the component/parameter results are outside the limits of the calibration model.

"No" results should be retained immediately for further calibration purposes. These samples will be used to ensure that future versions of the calibration are made more robust and these samples' spectra will be added to the calibration database. "No" samples are to be reported to the NLT immediately. These samples will most probably contain excess foreign material, which may be removed, and the sample reanalysed. If a further "No" match is obtained, the results cannot be used and should be reported to the NLT as such.

4. QUALITY STANDARDS

- Maximum moisture is allowed to prevent mould and heating, as determined by an NIR instrument = 16%.
- Loads containing harmful plants and proclaimed weeds are returned.
- Loads issuing strange smells, mould, and any signs of over-heating can be downgraded or returned.
- Loads that are obviously of mixed quality will be classified as the lowest grade within the load.

Table 4.1: Quality standards – National Lucerne Quality Index (NLQI)

Grade	NLQI	Foreign material
Supreme	108 and higher	Absent
Prime	104–107	Absent
Grade 1	100–103	Absent
Grade 2	95–99	Present
Grade 3	94 and less	Present

Source: HJ van der Merwe and GDJ Scholtz, 2010

Table 4.2: Forbidden and harmful plants

Family	Genus	Species
Convolvulaceae	*Cuscuta* spp	*C. campestris* (common dodder); *C. suaveolens* (lucerne dodder)
Poaceae	*Nasella* spp	*N. tenuissima* (white tussock); *N. trichotoma* (nassella tussock)
Solanaceae	*Datura* spp	*D. stramonium* (common thorn apple); *D. innoxia* (downy thorn apple); *D. ferox* (large thorn apple)
Solanaceae	*Solanum* spp	*S. elaeagnifolium* (silver-leaf bitter apple); *S. mauritianum* (bugweed); *S. seaforthianum* (potato creeper); *S. sisymbriifolium* (dense-thorned bitter apple)
Asteraceae	*Senecio* spp	*S. latifolius* (groundsel); *S. burchellii* (guanobush)
Dichapetalaceae	*Dichapetalum* spp	*D. cymosum* (poison leaf)
Fabaceae	*Crotalaria* spp	*C. spartioides* (besembossie); *C. dura* (wild lucerne), *C. burkeana* (bottlebrush)
Hyacinthaceae	*Ornithogalum* spp	*O. thyrsoides* (star-of-Bethlehem)
Iridaceae	*Moraea* spp	*M. pallida* (yellow tulp); *M. miniata* (red tulp); *M. polystachya* (poison moraea)
Ergot poisoning		Rye, triticale, barley, wheat, oats, and a few different types of grass (for example ryegrass, among others) are also susceptible to ergot contamination

Figure 4.1: *Cuscuta* spp

Figure 4.2: *Nasella* spp

Figure 4.3: *D. stramonium*

Figure 4.4: *S. elaegnifolium*

Figure 4.5: *S. latifolius*

Figure 4.6: *D. cymosum*

Figure 4.7: C. dura*cymosum*

Figure 4.8: *O. thyrsoides*

Figure 4.9: *M. thyrsoides*

Figure 4.10: Ergot poisoned grass

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