**Beef Production:** The Basics

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# Crop Residues for Animal Feeding

## Introduction

The human population explosion is a source of worry throughout the world. Food shortages and famine are becoming endemic in many places. The population explosion is associated with a reduction in farmable land and there are indications that food production is reaching the upper limits possible with present technology, available finances and water. To address these problems, scientists are investigating alternative food sources and evaluating present land use and utilization of food. Thus, feeding grains to ruminants is questioned because man, a monogastric, can utilize grains directly. On the other hand, ruminants are characterized by their ability to convert low quality roughage to meat, milk, natural fibres, leather and manure, products that are useful to man. Therefore, ruminants should ideally:

- graze non-arable areas
- utilize crop residues.

When crops are reaped, residues become available. Thus, when reaping cabbages, discarded leaves comprise up to 6 tons of edible dry matter per ha. Often markets collapse (*e.g.* potatoes) and it is too expensive to send produce to market and this "waste" (crop residue) becomes available for animal feeding. Carrots damaged at harvesting or discarded because of poor quality, comprise a good ruminant feed when fed with carrot tops.

After reaping, the first decision the farmer has to make is whether the residues must be left on the land, *i.e.* ploughed in, or utilized in some other way. This decision depends on a number of factors, including:

- the type and quality of the residues
- the price of animal products in relation to the prices of animal feeds
- the relationship between prices of bought feeds and the cost of feeding crop residues
- availability of livestock to utilize the residues
- type and species of livestock available to utilize the residues
- the price of livestock.

Careful evaluation of all these factors, especially a comparison of prices to determine that option with the greatest potential to make a profit, must be undertaken on each occasion when crop residues become available. People tend to do their sums with care when experiencing financial difficulties, but all too often, when things are going well, profits are lost through neglect.

## Crops and crop residues

Although almost any crop residue can be fed to livestock, the residues of maize, sugar cane, grain sorghum, soybean, wheat and vegetables are usually involved in animal feeding.

The first essential step when deciding to use any product as feed, is to prevent losses resulting from the presence of toxins and poisons. Poisoning can range from acute cases where animals die when ingesting the poison, to very low levels of poisoning where the consequence of ingesting a deleterious substance can only be measured as a negative effect on performance. Poor growth or a reduced ability to fatten can be the sole indicators that there is a problem, but, unfortunately, these symptoms are not specific to poisoning. Toxicity can arise when nutrients, although present and often required in the normal diet, fed in excess or in imbalance with other nutrients, result in poisoning of an animal's normal production systems. Poisons in feeds also include substances produced by the crop itself, poisons applied to the crop (*e.g*. insecticides or herbicides) and toxins produced by moulds and fungi. Steps to prevent problems are:

- when a farmer is unfamiliar with the feeding qualities of the relevant crop residues, enquiries concerning the suitability of the residues as animal feed can be directed to an agricultural advisor or the literature could be consulted
- an effort must be made to find out if the residues were exposed to moisture for any length of time and if so, the residues must be examined for signs of fungal growth or, even better, the crop residue can be tested for fungal toxins
- farmers must always be aware of the potential danger lurking where man-made poisons are sprayed onto crops, and directions for the safe use of these products must be followed
- poor animal performance must always be investigated to find out possible causes.

Problems experienced when feeding crop residues include:

- bloat, although uncommon
- many crops are prone to regrowth and the young shoots cause prussic acid poisoning - the sorghums are known for this problem when late rains and high temperatures stimulate plant growth
- the brassicas (cabbage, cauliflower, brussel sprouts) all produce substances that block the uptake of iodine and when animals graze these crops or the residues for a long, uninterrupted period, iodine deficiency symptoms occur (*e.g.* abortions and death of young animals)
- some crops produce toxins, which include the trypsin inhibitors of soybeans (not a problem for ruminants) and solanin, which is present in the leaves of many plants, especially potatoes
- livestock can choke on tubers, maize cobs and other large pieces of food
- blockage of the oesophagus in ruminants, which happens when animals only succeed in partly swallowing solid pieces of food such as tubers of potatoes, carrots or radishes, results in severe bloat and death.

Prussic acid (hydrocyanic acid) poisoning can be prevented by feeding a sulphur-containing lick to the animals, or better, lace the drinking water with "hypo" (sodium thiosulphate). Poisoning with prussic acid can be avoided by preventing livestock from grazing sorghum that was frosted or the young regrowth of the crop. Where potato leaves are fed as a small proportion of the diet, animals do not ingest enough solanin to cause major upsets, although production can be suppressed. Feeding of potato leaves should therefore only be undertaken in times of major food shortages. It is noteworthy that potatoes (which is a high energy feed for ruminants and monogastrics) that have been exposed to light and are greening, also produce toxic levels of solanin. It is good practice to chop up tubers of any crop (*e.g.* potatoes, carrots, radish) before feeding to prevent choking or blockage of the oesophagus.

### *Yield and quality*

The quantity of available crop residues is affected by all the factors that normally affect the yield of a crop. Another important factor affecting the quantity of residue available for feeding, is that animals graze selectively, usually utilizing only certain parts of a plant or specific fractions of crop residues. When grazing residues, trampling contributes to the loss of edible material. Collecting the residues and processing it (*e.g.* milling) increases the amount of residue ingested by the animal, but is associated with reduced animal performance because animals are forced to eat lower quality material. Intake and quality can be improved by additives *e.g.* spraying residues with molasses or feeding a rumen-stimulating lick such as one containing urea.

A number of factors affect the quality of residues, including:

- weathering occurs when left for a time before grazing commences, leaching of nutrients and damage by rain can severely reduce the nutritional value of crop residues
- mode of harvesting has been shown to affect quality of residues significantly, especially the amount of wastage of grain (more grain left on the land results in a higher quality residue) that takes place at harvesting as well as the extent to which the harvesting process shatters coarse plant parts such as stems
- cultivar plays a role
- plant density and crop yield has an effect
- with grain crops, where grain formation is limited by factors such as drought, the residues often are of higher quality because nutrients are not translocated from the stem and leaf to the grain.

Because animals selectively graze crop residues, an analysis of the residues is a poor reflection of the nutritional value of the residues. Where residues are collected and milled, a chemical analysis will provide only an approximation of feeding value because this analysis reflects the composition of the whole plant, whereas the fraction animals select is usually of a higher nutritional value. Should a farmer, through chemical analysis of residues or poor performance of livestock eating the residues, become aware of deficiencies in feeding value, then the alternative of returning the plant nutrients to the soil by ploughing in the residues, must be considered. Composting the residues is another alternative. The decision to plough residues into the soil or composting it is usually affected by the need for roughage *e.g.* in times of drought and feed shortages, low nutritional value is less important than availability and relatively higher costs of feeds could make crop residues a viable proposition.

### *Supplementation*

The feeding of the usual licks to animals on crop residues is recommended and for certain cases, especially low quality feeds, supplementation is essential.

## Maize crop residues

Maize crop residues have been used for feeding livestock, both cattle and sheep, for many generations and remains one of the cheapest and best ways for winter feeding in sourveld areas and as an additional source of income in maize producing areas. Because of the cost involved in collecting the residues or baling it, the usual practice is to graze the residues *in situ*. An important consideration is that removal of residues from a field removes plant nutrients, which must be replenished by fertilization, whereas grazing assists breakdown of residues and the return of nutrients to the soil. On the other hand, trampling by livestock has been held responsible for soil compaction.

*Maize crop residue yield*

As a rule of thumb, it is often assumed that the amount of crop residues left on the land after harvesting is equal to the grain yield of the relevant season. Research findings at Dundee indicate that residue yield is higher than grain yield. The rule of thumb for estimating residue yield should be used when a yield determination of the residues is not undertaken. However, to ensure optimal use of the crop residues, a yield determination should be made by collecting and weighing the residues on at least 5 randomly selected sites, each comprising $20m^2$ , on the land. From this data the yield per ha can be calculated.

*Maize crop utilization*

When grazing maize crop residues, grazing can only commence after the grain has been harvested, which, especially during a wet season when it takes a long time for the grain to dry to the required moisture content (17% or less), could delay the start of grazing deep into the winter, causing a gap in the fodder supply to a herd. At the end of the winter, grazing is terminated by the need to start land preparation for the next season's maize planting. The result is that, in KwaZulu-Natal's maize producing areas, grazing of residues usually only starts in mid June and must be terminated by the end of September. At most, 100 grazing days are therefore possible.

In many trials in South Africa and elsewhere, including the United States of America, animals utilize approximately 40% of maize crop residues. The fractions utilized by cattle grazing maize crop residues at Dundee (Table 10) clearly shows that the grain and leaves are utilized the most.

**Table 10.** The utilization of maize crop residues by pregnant beef cows as shown by the composition of the residues, pre- and post-grazing, in a trial ran at the Dundee Research station over 3 years.

| Time sampled | Maize crop residue component | | | | |
|---|---|---|---|---|---|
| | Maize grain (ton/ha) | Cob (ton/ha) | Leaf (ton/ha) | Stalk (ton/ha) | Total (ton/ha) |
| Pre-grazing | 0.201 | 1.47 | 3.17 | 2.52 | 7.4 |
| Post-grazing | 0.066 | 1.03 | 1.31 | 1.63 | 4.1 |
| % Utilized | 67.2 | 29.9 | 58.7 | 35.3 | 44.6 |

*Animal performance*

In trials at the Dundee Research Station, pregnant beef cows and different ratios of cattle (heifers) and sheep (wethers) were grazed on maize crop residues. The results of the latter trial showed that cattle alone and cattle with sheep provide a higher live mass gain per ha than grazing maize crop residues with sheep alone.

When comparing the performance of pregnant beef cows when strip- or continuous grazing maize crop residues at Dundee, the cows tended to gain live mass and body condition initially, retained this live mass and condition for up to 6 weeks (although condition score did tend to decline gradually between week 4 and week 7 of grazing), and then tended to lose weight and condition relatively rapidly at about 7 to 8 weeks of being on the residues (Figure 10 and Figure 11). The pattern for steers on the residues was similar. The finding that body condition declined rapidly after 56 grazing days on maize crop residues has important implications for the commercial farmer. If the objective is to overwinter animals irrespective of performance, maize crop residues can be grazed for a longer period.

However, if the farmer wishes to retain cattle in good condition, then grazing should be terminated before body condition crashes, which is apt to happen when the residues are depleted.

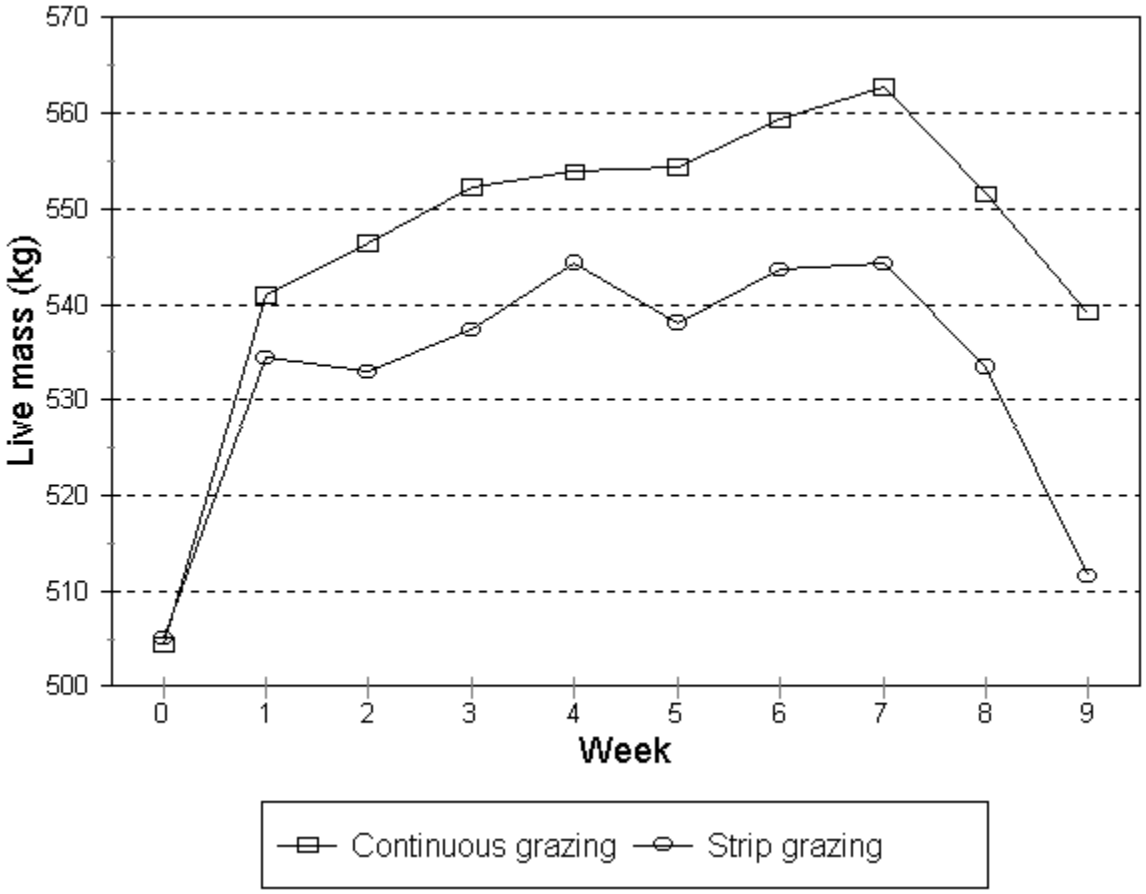


**Figure 10.** Live mass changes of pregnant beef cows subjected to continuous and strip grazing maize crop residues for 9 weeks.

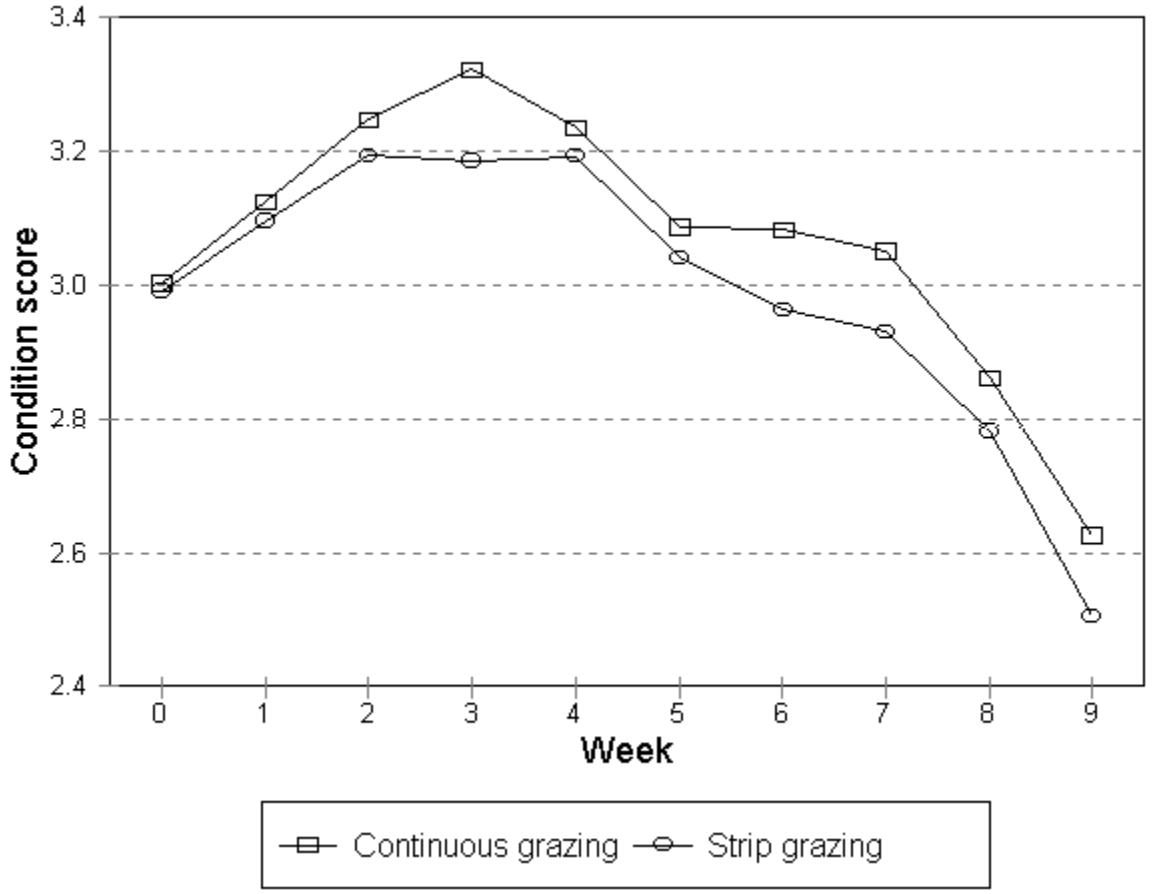


**Figure 11.** Condition score changes in pregnant beef cows grazing maize crops residues for 9 weeks.

### *Stocking rate*

From the research at Dundee, it was concluded that a practical method to calculate the correct stocking rate for cattle on maize crop residues is as follows:

1. Establish how much residue is left on the land. If a residue yield determination is not undertaken, assume that amount of residue is equal to amount of grain harvested.
2. Establish number of grazing days based on when the grain is harvested up to the time when land preparation will commence. Although 100 grazing days is theoretically possible, animal performance in the Dundee trials indicated that it would be better to assume 80 days as the upper limit for number of grazing days for wintering only and 60 days if body condition is to be retained.
3. Allow 60% wastage.
4. Calculate daily animal dry matter intake, which in the case of a cow (mature livestock equivalent *i.e.* a mature animal weighing 450 kg, which is more or less equal to 6 wethers weighing 45 kg each) would be 10 kg/day.
5. Calculate stocking rate.

Example:

1. 4 tons of maize grain harvested = 4 tons of residues.
2. Grazing will commence 30 June and will end 15 September = 78 grazing days (farmer wishes to overwinter only, therefore there is no adjustment because days < 80).
3. 40% of 4 tons = 1600kg

4. Daily dry matter intake = 10 kg
5. 2.08 cows / ha (or 12.5 wethers/ha) can graze these residues for 78 days.

Cow days is first calculated by dividing the amount of dry matter by the daily intake. The stocking rate (cows/ha) is then the cow days divided by the number of grazing days, as follows:

$$\frac{1600}{10} = \text{cow days,}$$

$$\frac{160}{78} = \text{stocking rate}$$

## Conclusion

Crop residues are a valuable source of animal feed and utilizing the residues by grazing is very effective in returning plant nutrients to the soil. In the USA, pigs are often used with cattle to utilize crop residues, whereas in South Africa, beef cattle alone or cattle with sheep are more commonly used. It is important to bear in mind that crop residues are low quality feeds and should therefore not be used for high producing animals like lactating cows or animals being finished for slaughter. Strategies worthy of consideration include:

- crop residues are retained for wintering beef cows or sheep (non-lactating)
- crops can be undersown with companion crops to enhance nutritional value of the residues
- supplements can be used to enhance nutritional value of the residues
- cattle or sheep can graze residues in addition to grazing quality pastures for a fixed period each day.

Excluding the first-mentioned strategy, little or no data is available on the best procedures to follow and for the time being, farmers will have to test some of these possibilities for their own situations. Balancing a ration with the relevant residues as one of the ingredients, can assist in providing a starting point for such investigations.