The potential of maize crop residues for wintering sheep on the eastern Transvaal Highveld

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Maize crop residues were grazed at three stocking rates, viz. 6, 9 and 12 sheep/ha, for about three months. Total DM yield of the maize crop was about 7500 kg/ha, and consisted of 38.5% grain and 61.5% residues. During harvesting, an average of 338 kg grain/ha was wasted. On average, crop residues consisted of 49% leaves, 31% stems, 3.5% cob leaves, 10% cobs and 6.7% grain. About 39% of the crop residues was removed during the grazing period. Weathering accounted for 21% loss of residual material on an adjacent site that was not grazed. Grain and finer leaf material were almost totally utilized, and oesophageal samples contained between 80 and 90% grain during the first four weeks of grazing. Thereafter, grain content fell sharply, with nutrient and energy content following suit. Stocking rate did not affect mass gains significantly (P < 0.05), but wool growth declined significantly with an increase in stocking rate. Nevertheless, these production parameters were higher with a stocking rate of 12 sheep/ha than with stocking rates of 6 and 9 sheep/ha, when production was calculated per hectare. Production levels were judged to be highly satisfactory, from which it was concluded that sheep may be successfully wintered for up to 1250 sheep grazing days.

Keywords: Maize residues, grazing, stocking rate, oesophageal samples, mass gains, wool production.

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Introduction

Wintering remains an area of major concern with regard to animal production in the eastern Transvaal Highveld, mainly because feed production is largely seasonal. Being essentially a summer rainfall area, occasional winter rainfall is insufficient for successful cultivation of dryland winter pasture. The provision of quality forage for the winter is further complicated by the nutritional value of sour grass veld which plummeted in the autumn and winter (Rethman, 1984). In fact, the production, palatability and nutritional value of the veld drop to such an extent that sheep cannot be wintered satisfactorily. A solution is to provide supplementary feeding (Barnard, 1976; Dreyer, 1980; Bekker & Stoltz, 1983). However, the cost of supplementary feeding may decrease profitability. Consequently, it is preferable to carry over forages produced in summer and/or use residues of summer cash crops.
Much is known about transferable forages such as silage (Van der Merwe et al., 1977; Giliomee, 1984) and hay, of which *Eragrostis curvula* is the most abundant in the region (Eeden & Beukes, 1984). In comparison to maize residues, transferable forages are relatively expensive. Therefore it is more acceptable to winter sheep on maize residues, provided that these residues are of acceptable nutritional quality.

Maize residues are usually collected mechanically and knowledge of the nutritional value, with or without alkali treatment, has been accumulated on a wide front (Berger et al., 1979; Bertelsen, 1981; Hofmeyr et al., 1981; Reid & Klopfenstein, 1983; Seed, 1983). According to Snyman (1985) and Schoonraad et al. (1987), mechanically collected maize residues are suitable for maintenance of ruminants, only when amply supplemented with nitrogen and phosphorus. This is not surprising, because the material collected by raking and baling consists mainly of stems and stem leaves which are of lower nutritional value than the grain and finer cob leaves (Henning & Steyn, 1984) which often remain on the land.

One of the aims of this study therefore was to determine the nutritional value of maize crop residues as selected by grazing sheep. Because of the expected higher quality of material selected by sheep compared to material collected by hand (Brendon et al., 1967; Engels & Malan, 1973; De Waal, 1979), it was expected that sheep would show some increase in mass and wool growth. This would make the practice of grazing maize crop residues highly economical, as shown by Lamm et al. (1977).

Further aims of the study were to determine the amount of residue available for grazing, the amount actually utilized, the applicable carrying capacity and to establish whether stocking rate has an effect on animal production.

**Procedure**

**Terrain**

The study was conducted at Wildebeesfontein, the experimental farm of the Eastern Transvaal Co-op, in the Middelburg district. The long-term, average annual rainfall is 727 mm (Botha et al., 1985) and is concentrated in the summer months, with the highest precipitation occurring during November, December and January. The precipitation during the year of study (1981/82) was lower (558 mm) than the long-term average, but the distribution corresponded well with normal patterns.

The yellow maize cultivar, SSIM72, was planted in October 1981 in rows 0.91 m apart on a medium-potential Glencoe soil with a clay percentage of 20. On November 28 and December 13 of 1981, hail damaged the crops to the extent that 38 and 12% of the grain respectively, was lost (stratified, randomized survey). Whereas it is difficult to judge whether the hail damage actually affected the outcome of this study, results from other studies examined in the Discussion section showed similar patterns. Also, the occurrence of hail in this particular area is more the rule than the exception, which adds credibility to the practical application of the results.

The crop was harvested in May 1982. Maize cobs not retrieved by the harvester were collected by hand. Grain yield averaged 2.95 t/ha (14% moisture), which is equivalent to 2.54 t DM. This value is lower than the long-term average, probably because of lower rain and hail damage than normal.

An area of approximately 6 ha in the centre of the maize field was used to study carrying capacity and animal performance. This area was divided into six camps, each of one hectare, with fencing erected according to a gradient of 3.3%. An adjacent area of 1.95 ha was also fenced and used to study selection by oesophageally fistulated sheep.

**Measurement of residue yield and composition**

Yield was determined in all camps before grazing, using six stratified, randomized, (3.64 × 2.47 m²) rectangles per camp. The side of 3.64 m was deliberately chosen, because the maize was planted by a four-row planter in 0.91-m rows and reaped with a four-row harvester, which is general practice in the Eastern Transvaal. Normally, this would give a plant density of 30 000 to 35 000 plants per hectare and a grain yield of 3 t/ha.

The residues were divided into leaves, cob leaves, stems, cobs and grain. After weighing each component separately, the residues were reconstituted and returned to the respective camps. Yields were estimated again at the end of the grazing period, using a neighbouring camp (1.14 ha) which had not been grazed, in order to estimate decay and loss by natural means.

Samples were collected by hand from the camps that were grazed at the beginning and end of the grazing period. These were analysed for nitrogen, crude fibre, ether extract, ash, P, Ca, Mg and K according to AOAC (1984).

**Stocking rate and trial animals**

A carrying capacity that is generally accepted in the Eastern Transvaal from crops that yield about 3 t grain/ha is 6 sheep/ha for 3—4 months. This capacity translates to 540—730 grazing days per sheep. Although ill-defined, this figure was nevertheless chosen as a starting point to determine the eventual carrying capacities used in this trial.

In the carrying capacity trial, 54 two-tooth Merino wethers of between 34 and 41 kg were allocated at random to three treatments in two repetitions. The three treatments consisted of 6, 9 and 12 sheep/ha respectively. These sheep grazed the six one-hectare farms for a period of 105 days. On the adjacent 1.95 ha camp, 18 two-tooth Merino wethers weighing 31.0—38.5 kg, four of which were oesophageally fistulated, were allowed to graze for 91 days. This represented a stocking rate of 9.23 sheep/ha.

Before initiation of the trials, sheep were treated for internal parasites and were then introduced to the crop residues without previous adaptation to the diet. The sheep were weighed at the start of the trials and once a week thereafter, after being kept from feed and water overnight. All sheep were shorn with electric shears nine days before the start of the trials and again at the end. Wool samples were obtained from the mid-rib position and sent to the Fleece Testing Centre for analysis.

All sheep had free access to water and a salt lick without P.

**Oesophageal extrusa collection**

Oesophageal samples were collected from the start of the trial on a weekly basis. After removal of excessive moisture from oesophageal samples by pressing through cheesecloth, the samples were stored in plastic bags in a deep-freeze. Samples were eventually dried in an extrusion oven at 60°C and were then divided into grain and roughage fractions. The components were weighed separately, reconstituted, ground, and stored in glass bottles with screw tops up to analysis.

The samples were analysed for nitrogen, crude fibre, ether extract, ash and Ca according to standard procedures (AOAC, 1984).
1984). The in vitro digestibility of OM was also determined by the method described by Tilley & Terry (1963), but the results proved to be unreliable during the first six weeks when the grain component of omasal extrusa was high. Total digestible nutrient (TDN) content was consequently calculated from regression equations calculated by Kearl (1982) for sheep, as follows:

1. For energy-rich feedstuffs with less than 20% crude protein and 18% crude fibre:
   \[ \text{TDN} \% = 2.6407 + 0.6964 \times \text{crude protein} \% + 0.2194 \times \text{nitrogen-free extract} \% + 1.2159 \times \text{ether extract} \% + 0.1043 \times \text{crude fibre} \% \]
2. For roughages which contain more than 18% crude fibre:
   \[ \text{TDN} \% = -14.3856 + 1.3310 \times \text{crude protein} \% + 0.7923 \times \text{nitrogen-free extract} \% + 0.9787 \times \text{ether extract} \% + 0.5133 \times \text{crude fibre} \% \]

Statistical analysis
Crop residue yield and animal production data were analysed according to a randomized block design by GLM procedure, using Tukey's test. The chemical composition of crop residues was not statistically analysed, but the standard deviations were calculated and presented with the means. Similarly, because there was only one stocking rate in the selection trial, only data means and standard deviations were calculated, and presented accordingly.

Results and Discussion
Crop residue yield
The crop residue yields before and after grazing are shown in Table 1.

Table 1  Crop residue yield and the amounts removed during grazing (kg DM/ha)

<table>
<thead>
<tr>
<th>Component</th>
<th>Leaves</th>
<th>Stems</th>
<th>Cob leaves</th>
<th>Cobs</th>
<th>Grain</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Yield</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Six sheep/ha</td>
<td>2393</td>
<td>1597</td>
<td>211(^a)</td>
<td>609</td>
<td>380(^a)</td>
<td>5189(^a)</td>
</tr>
<tr>
<td>Nine sheep/ha</td>
<td>2092</td>
<td>1487</td>
<td>119(^a)</td>
<td>362</td>
<td>270(^a)</td>
<td>4530(^a)</td>
</tr>
<tr>
<td>Twelve sheep/ha</td>
<td>2566</td>
<td>1662</td>
<td>174(^b)</td>
<td>519</td>
<td>364(^b)</td>
<td>5286(^b)</td>
</tr>
<tr>
<td>MSD*</td>
<td>299</td>
<td>193</td>
<td>33</td>
<td>118</td>
<td>50</td>
<td>358</td>
</tr>
<tr>
<td>Selection trial</td>
<td>2809</td>
<td>1428</td>
<td>197</td>
<td>573</td>
<td>336</td>
<td>5343</td>
</tr>
<tr>
<td><strong>Removed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Six sheep/ha</td>
<td>868(^f)</td>
<td>189(^a)</td>
<td>181</td>
<td>316</td>
<td>379(^x)</td>
<td>1933(^x)</td>
</tr>
<tr>
<td>Nine sheep/ha</td>
<td>89(^a)</td>
<td>565(^x)</td>
<td>105</td>
<td>123</td>
<td>267(^a)</td>
<td>1149(^a)</td>
</tr>
<tr>
<td>Twelve sheep/ha</td>
<td>838(^f)</td>
<td>678(^x)</td>
<td>165</td>
<td>212</td>
<td>363(^x)</td>
<td>2255(^x)</td>
</tr>
<tr>
<td>MSD</td>
<td>350</td>
<td>183</td>
<td>39</td>
<td>116</td>
<td>50</td>
<td>446</td>
</tr>
<tr>
<td>Selection trial</td>
<td>1363</td>
<td>586</td>
<td>178</td>
<td>161</td>
<td>335</td>
<td>2623</td>
</tr>
</tbody>
</table>

\(^{a, b, c, x, y}\) Values in the same column with different superscripts differ significantly \((P < 0.05)\).

* Mean standard deviation.

The total DM yield before harvesting was about 7500 kg/ha, which consisted of 38.5% grain and 61.5% residues. According to Dreyer (1980), residues should make up 54.5% of the total yield of a maize land which yields 2500 kg grain/ha. Lamn & Ward (1981) found that, with a relatively high grain yield of 5000 kg/ha, the residue component constituted 55.2% of the total yield. In general, it appears that the residue component is usually larger than the grain component, but the difference may vary depending on grain yield as well as cultivar, soil type and climatic conditions.

During harvesting, an average of 338 kg grain/ha was wasted, although the value on the farms with a stocking rate of 9 sheep/ha was significantly lower. The total yield of residues on these farms, however, was also lower than on farms with a stocking rate of 6 and 12 sheep/ha (Table 1); an unexpected result. A wastage of 11.5% of grain yield (2950 kg/ha) was recorded, which is higher than the 8.9% reported by Swart et al. (1983) with a grain yield of 3490 kg/ha, and the 6.8% reported by Schoonraad (1985) when the grain yield was 7400 kg/ha. Thus, it appears that the percentage wastage was higher with lower grain yields. A possible explanation for this observation is that, in general, smaller kernels are found with lower grain yields and these grains are not collected as effectively by a harvester as the heavier kernels. There may be other explanations such as the efficiency of grain collection by the harvester, as reported by Lamn & Ward (1981), who found a relatively high grain wastage of 13.8% when the grain yield was 5000 kg/ha.

On average, crop residues consisted of 49% leaves, 31% stems, 3.5% cob leaves, 10% cobs and 6.7% grain, with little difference between treatments, despite the significantly lower yield (Table 1) obtained from the treatment of 9 sheep/ha. This yield of leaves is somewhat more than those quoted by Lamn & Ward (1981) and Schoonraad (1985), which may be partially explained by the hail damage. Lamn & Ward (1981) determined the composition to be 39% leaves, 41% stems, 9.1% cob leaves and 11% grain, while Schoonraad (1985) reported a composition of 40% leaves, 31% stems, 22% cobs and 6.5% grain. Leaves and stems clearly constituted the largest portion of maize crop residues, followed by cobs and grain.

There was no significant difference in the amount of cobs and cob leaves removed (Table 1). Cob leaves, in fact, were almost totally utilized, as was grain. This corresponds to the results of Estervuyse (1990). Less stems were removed at a stocking rate of 6 sheep/ha \((P > 0.05)\), while less leaves were removed at the stocking rate of 9 sheep/ha. On average, the residues removed from the total area were 32% leaves, 33% stems, 90% cob leaves, 39% cobs and 99.5% grain. Of total residues, about 39% were removed with relatively small differences between treatments. By comparison, values from the literature vary between 32 and 36% (Weber et al., 1983; Schoonraad, 1985; Estervuyse, 1990). It appears therefore, that no more than 40% of residues is utilized under normal grazing conditions when realistic stocking rates are employed.

It is not clear whether this selective removal of residues will influence future grain production. According to Koster et al. (1987), the average grain yield over eight years on sites where residues were totally removed, was 4780 kg/ha compared to 4940 kg/ha where residues were not removed. No significant fluctuations in annual grain production were recorded during this period. It can thus be concluded that grazing of maize
residues at realistic stocking rates of up to 12 sheep/ha would probably not be detrimental to future grain production.

Observations on the neighbouring ungrazed (control) site are shown in Table 2.

### Table 2 Crop residue yield on the control site (kg DM/ha)

<table>
<thead>
<tr>
<th>Component</th>
<th>10 June</th>
<th>23 September</th>
<th>Decayed or lost (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaves</td>
<td>1554 ± 630*</td>
<td>1107 ± 736</td>
<td>447 (29)</td>
</tr>
<tr>
<td>Stems</td>
<td>1332 ± 330</td>
<td>1259 ± 371</td>
<td>73 (5)</td>
</tr>
<tr>
<td>Cob leaves</td>
<td>186 ± 97</td>
<td>131 ± 82</td>
<td>55 (30)</td>
</tr>
<tr>
<td>Cobs</td>
<td>410 ± 235</td>
<td>310 ± 205</td>
<td>100 (24)</td>
</tr>
<tr>
<td>Grain</td>
<td>352 ± 178</td>
<td>218 ± 224</td>
<td>134 (38)</td>
</tr>
<tr>
<td>Total</td>
<td>3834 ± 951</td>
<td>3025 ± 1413</td>
<td>809 (21)</td>
</tr>
</tbody>
</table>

* Standard deviation.

After a period of 105 days (10 June—23 September), 21% of the residues had disappeared, whereas the percentages for the readily perishable components, such as leaves, were higher. Lamm & Ward (1981) reported a decay and disappearance of 37% over an 86-day period during which snow had fallen. Schoonraad (1985) found a decay of 11% after 91 days. It thus appears that a relatively large percentage of residues is lost as a result of wind and decay.

### Chemical composition of residues

The chemical composition of samples collected by hand, before and after grazing, is shown in Table 3.

The results from carrying capacity and the selection study corresponded fairly well. Also, the chemical composition of residues from the different camps and replications of the carrying capacity study did not differ either before or after grazing (see MSD values in Table 3). Crude protein content decreased by about 1% and the ether extract by 0.5% during the grazing period. By contrast, the mineral contents remained approximately the same, with some evidence of a possible increase in Ca.

However, it should be borne in mind that, because these samples were collected by hand, the composition reported here was not necessarily representative of the diet that would have been selected by the sheep. The composition should rather be seen as representative of the total available residues. The chemical composition of material actually selected by oesophageally fistulated sheep is presented in Table 4.

### Table 3 Chemical composition of residues collected by hand before and after grazing (% of DM)

<table>
<thead>
<tr>
<th>Item</th>
<th>Crude protein</th>
<th>Ether extract</th>
<th>Crude fibre</th>
<th>Ash</th>
<th>P</th>
<th>Ca</th>
<th>Mg</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Six sheep/ha</td>
<td>6.80</td>
<td>0.91</td>
<td>34.7</td>
<td>6.38</td>
<td>0.13</td>
<td>0.44</td>
<td>0.28</td>
<td>1.04</td>
</tr>
<tr>
<td>Nine sheep/ha</td>
<td>6.88</td>
<td>1.23</td>
<td>35.3</td>
<td>6.36</td>
<td>0.14</td>
<td>0.51</td>
<td>0.29</td>
<td>0.91</td>
</tr>
<tr>
<td>Twelve sheep/ha</td>
<td>6.54</td>
<td>0.88</td>
<td>32.0</td>
<td>6.03</td>
<td>0.12</td>
<td>0.48</td>
<td>0.27</td>
<td>0.98</td>
</tr>
<tr>
<td>MSD*</td>
<td>0.81</td>
<td>0.23</td>
<td>6.43</td>
<td>1.89</td>
<td>0.03</td>
<td>0.08</td>
<td>0.02</td>
<td>0.14</td>
</tr>
<tr>
<td>Selection trial</td>
<td>6.02</td>
<td>1.09</td>
<td>31.6</td>
<td>5.23</td>
<td>0.44</td>
<td>0.28</td>
<td>0.92</td>
<td></td>
</tr>
<tr>
<td>After</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Six sheep/ha</td>
<td>5.40</td>
<td>0.66</td>
<td>–</td>
<td>–</td>
<td>0.17</td>
<td>0.54</td>
<td>0.25</td>
<td>0.68</td>
</tr>
<tr>
<td>Nine sheep/ha</td>
<td>5.18</td>
<td>0.71</td>
<td>–</td>
<td>–</td>
<td>0.17</td>
<td>0.60</td>
<td>0.24</td>
<td>0.56</td>
</tr>
<tr>
<td>Twelve sheep/ha</td>
<td>5.01</td>
<td>0.66</td>
<td>–</td>
<td>–</td>
<td>0.16</td>
<td>0.59</td>
<td>0.25</td>
<td>0.61</td>
</tr>
<tr>
<td>MSD</td>
<td>0.81</td>
<td>0.23</td>
<td>–</td>
<td>–</td>
<td>0.02</td>
<td>0.11</td>
<td>0.02</td>
<td>0.17</td>
</tr>
<tr>
<td>Selection trial</td>
<td>5.05</td>
<td>0.46</td>
<td>–</td>
<td>–</td>
<td>0.58</td>
<td>0.26</td>
<td>0.70</td>
<td></td>
</tr>
</tbody>
</table>

* Mean standard deviation.

Examination of the contents of oesophageal extrusa showed that the sheep had selected mainly grain during the first 4—5 weeks of grazing (Table 4). The high grain fraction is cause for concern because of the probability of acidosis. Therefore, it is advisable to adapt sheep to concentrate feeding before they are introduced to maize crop residues. After six weeks of grazing, grain was still selected in substantial portions but, from nine weeks onwards, oesophageal extrusa consisted mainly of roughage material.

Because of the high grain content during the early grazing period, the chemical composition and energy content of extrusa samples corresponded to the chemical composition of maize grain (Table 4). As from about week 5, the crude protein content declined from ca. 8 to 5 or 6% where it stabilized. A level of 5—6% may be marginal for effective fermentation (Miron, 1977). Pregnancy toxemia is often encountered in heavily pregnant ewes on crop residues. From the present results, it is clear that energy would not have been limiting in this trial, at least during five to six weeks of grazing. However, because nitrogen may be marginal, ineffective fermentation may have prohibited maximal DM intake. Therefore it is suggested that maize crop residues fed to pregnant ewes should be supplemented with nitrogen. This was also proposed by Esterhuyse (1990).
Either extract and TDN gradually decreased as the content of roughage material increased (Table 4). In contrast, crude fibre, ash and Ca increased later during the grazing period. The high ash content towards the end of the grazing period may have been due to the ingestion of large amounts of soil. The sheep may have continued to seek out grain particles when none were left. It was observed that the soil was often scraped away with a hoof in an effort to find grain.

In comparing Tables 3 and 4, it is evident that the composition of hand-collected samples differed vastly from oesophageal samples and that the sheep managed to select a diet of much higher quality than that available from the crop residue, on average, during the first seven weeks.

**Animal production**

Mass gains, wool production and physical characteristics of wool during the grazing period are shown in Table 5.

Stocking rate did not influence mass gains significantly, although there might have been a tendency for mass gains to decline with stocking rate. Surprisingly, values for mass gains in the selection trial were much higher. While the reason for this is not clear, sheep in that study utilized more oesophageal samples and that the sheep managed to select a diet of a much higher quality than that available from the crop residue, on average, during the first seven weeks.

### Table 5 Mass gains, wool production and physical characteristics of wool during the grazing period

<table>
<thead>
<tr>
<th>Item</th>
<th>Mass gains (kg/sheep)</th>
<th>Clean fleece yield (kg/sheep)</th>
<th>Clean fleece (%), Fibre diameter (micron), Staple length*, Crimp deviation (index)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Six sheep/ha</td>
<td>7,75</td>
<td>1,37*</td>
<td>62,5, 22,8, 108, 95,8</td>
</tr>
<tr>
<td>Nine sheep/ha</td>
<td>6,56</td>
<td>1,28*</td>
<td>63,0, 21,1, 102, 91,6</td>
</tr>
<tr>
<td>Twelve sheep/ha</td>
<td>5,75</td>
<td>1,17*</td>
<td>63,2, 20,8, 99,3, 90,4</td>
</tr>
<tr>
<td>MSD**</td>
<td>0,90</td>
<td>0,07</td>
<td>1,80, 0,71, 5,24, 2,69</td>
</tr>
<tr>
<td>Selection trial</td>
<td>11,1</td>
<td>1,44</td>
<td>21,7, 110, –</td>
</tr>
</tbody>
</table>

*Values in the same column with different superscripts differ significantly (P < 0.05).

* Staple length was adjusted proportionally to 365 days wool growth.

** Mean standard deviation.
however, showed no significant differences in clean fleece percentage between stocking rates (Table 5), and the recorded percentages of about 63% were comparable to the 63,3% recorded by Esterhuyse (1990) on maize residues and the average of 64,2% calculated for 1017 samples by the Fleece Testing Centre (Erasmus & Delport, 1987). These samples were considered to be fairly representative of the national wool clip.

Overall, the animal production data obtained from a stocking rate of 9 sheep/ha is in line with the production data obtained from stocking rates of 6 and 12 sheep/ha (Table 5). This suggests that the significantly lower availability of residues for this treatment (Table 1) was not a limiting factor in realizing comparable levels of animal production.

Conclusions
It is generally accepted that the residue component from a maize crop is approximately equal in mass to the grain yield but, from this and other studies, it is clear that the residue component is usually larger. Leaves and stems constitute the major portion of this residue followed by the contribution from cobs, grain and cob leaves.

Of the total residues, 39% was removed during the grazing period, which apparently includes losses due to weather conditions. Losses due to decay and other reasons may be substantial, as shown by the substantial loss of 21% measured on a neighbouring ungrazed camp over the same three-month period. The finer leaf and grain components of the residues were almost totally utilized. In fact, analyses of oesophageal samples indicated that 80—90% of the material ingested consisted of grain with some fine leaf material during the first four weeks of grazing. A practical advantage of this preference for grain is that regrowth of maize in the next season is virtually eliminated.

Furthermore, analyses of oesophageal samples indicated that the nutritional value of maize residues selected by sheep was generally much higher than that of residues collected mechanically. This was supported by the satisfactory levels of mass gains and wool growth realized in this study, compared to the significantly lower availability of residues for the area may be higher than the accepted standard of 6 sheep/ha for three to four months. Although stocking rate significantly influenced production per animal, satisfactory production was still achieved at a stocking rate of 12 sheep/ha over a grazing period of 105 days. A grazing capacity of 1 250 sheep grazing days on maize residues in the eastern Transvaal Highveld is thus possible, which elucidates the high potential of maize residues to winter sheep successfully and cheaply.

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