THE VALUE OF COTTONSEED ALONE AND WITH WHEAT IN DROUGHT FEEDING OF SHEEP

P. McINNES,* T. W. MILLS,† and J. KEOGH‡

Summary
Ten non pregnant, non lactating Corriedale ewes ate an average of 148 g fuzzy whole cotton seed per sheep per day and their mean weight fell from 40.3 to 32.2 kg over an eight week period. Two of the sheep died. A similar group of ewes, offered a mixture of 227 g of cottonseed and 227 g of wheat per sheep per day, usually ate all the ration. At the end of an 18 week period, there were no significant differences between the mean body weight loss (1.7 kg) and the mean clean fleece weight (0.92 kg) of these ewes and another group given 454 g of wheat per sheep per day that lost 3.3 kg per sheep and produced 0.90 kg clean wool per sheep.
At the end of the experiment, sheep fed the cottonseed/wheat mixture showed elevated glutamate-oxacetate transaminase levels in blood serum, and hypertrophy of the heart was observed in four of five sheep autopsied.

I. INTRODUCTION
During the drought of 1965 in N.S.W., many farmers enquired about the feeding value of fuzzy cottonseed for sheep that were being partially or completely hand-fed. No information is available on the feeding value of locally produced cottonseed but, in the U.S.A., Ramsey and Miles (1953) reported that up to 2.5 kg of cottonseed per cow per day could safely be incorporated in diets fed to dairy cows.
Wheat was generally the most economic and readily available fodder to purchase during the drought (McInnes 1965). In the first few months of the drought, the cost of fuzzy cottonseed was about $42 per 900 kg compared to $55 for the same quantity of wheat. Although it is difficult to estimate, it would appear that at least 1,000 tons of fuzzy cottonseed was given to stock during 1965.
The aim of the present experiment was to compare the performance of sheep fed either cottonseed alone, or a mixture of equal amounts of cottonseed and wheat, with sheep fed wheat alone.

II. MATERIALS AND METHODS
(a) Sheep and Location
Thirty non-pregnant, non-lactating Corriedale ewes 3% or 4½ years of age were used. These sheep had been shorn in mid-February 1966 at the Agricultural Research Station, Temora, N.S.W., and had grazed together between shearing and the start of the trial.
(b) Treatment and Management
On April 4, the sheep were weighed and divided by stratified random sampling based on body weight into three groups of ten sheep. Each group was placed in a

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bare and unshaded yard and was fed during a period of six weeks decreasing quantities of hay and increasing amounts of wheat, cottonseed, or a mixture of each. At the end of this period, Group 1 was fed 454 g of fuzzy whole cottonseed per sheep per day (lint plus husk, approximately 43% of the whole seed), Group 2 was fed 227 g of fuzzy whole cottonseed plus 227 g of whole wheat grain per sheep per day, and Group 3 was fed 454 g of whole wheat grain per sheep per day. Following the procedure practised in the drought, a calcium supplement was not given to Group 1, but 1½% of finely ground limestone was added to the diets of Groups 2 and 3 to give a calcium : phosphorus ratio of approximately 1 : 1. The dry matter and crude protein content of the wheat and cottonseed are given in Table 1.

The groups were fed three times a week on Monday, Wednesday and Friday, and residues were collected and measured before feeding. Sheep were weighed each Wednesday before feeding. The experiment continued for 18 weeks to September 14 when sheep in Groups 2 and 3 were shorn. Greasy fleece weights were recorded and mid-side samples were taken at shearing for determination of clean fleece weight.

(c) Chemical and Post-mortem Observations

On September 15, after a fasting period of at least 24 h, blood samples were obtained from the jugular vein of all sheep in Group 2. Serum samples were used for the determination of glutamate oxalacetate transaminase (GOT) by the method of Reitman and Frankel(1957).

After bleeding, five sheep in Group 2 were chosen at random and slaughtered for post-mortem examination. Sections of liver, kidney and heart were collected for histopathological examination.

(d) Digestibility Trial

Digestibility studies were made at Hawkesbury Agricultural College, N.S.W., with samples of the feed that had been used at Temora. Eight one-year-old Merino Wethers which had been totally hand-fed for six months were used. Four of these sheep were individually fed wheat daily and four were similarly fed a mixture of equal amounts of cottonseed and wheat. The quantities and limestone supplements were the same as used in the group trial. Faeces and feed residues were measured daily for eight days. The sheep were slaughtered at the end of the trial for post-mortem examination.

<table>
<thead>
<tr>
<th>Feed</th>
<th>Dry Matter</th>
<th>Crude Protein</th>
<th>Digestible Crude Protein</th>
<th>Digestible organic matter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>87.2</td>
<td>10.8</td>
<td>8.9</td>
<td>89.2</td>
</tr>
<tr>
<td>Cottonseed</td>
<td>90.1</td>
<td>22.4</td>
<td>13.9</td>
<td>60.1</td>
</tr>
</tbody>
</table>

*Values based on oven dry matter.
TABLE 2

Initial body weight, weight changes, and clean fleece weight of sheep fed wheat and cottonseed

<table>
<thead>
<tr>
<th>Group</th>
<th>Diet and level of feeding* (g/sheep/day)</th>
<th>Initial mean weight† (kg)</th>
<th>Mean change in weight over 18 weeks (kg)</th>
<th>Clean fleece weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>227 g wheat plus 227 g cottonseed</td>
<td>40.6</td>
<td>-1.7</td>
<td>0.92</td>
</tr>
<tr>
<td>3</td>
<td>454 g wheat</td>
<td>40.0</td>
<td>-3.3</td>
<td>0.90</td>
</tr>
</tbody>
</table>

*Finely ground limestone added to both diets to produce a calcium : phosphorus ratio of 1 : 1.
†Corrected for wool weight.

III. RESULTS

(a) Body Weight Changes and Clean Fleece Weight

During the first eight weeks, the mean body weight of Group 1 fell from 40.3 to 32.2 kg* and two deaths occurred, one during the fourth, the other during the fifth week. At post-mortem, several fibre balls 1 to 4 cm in diameter were found in the rumen of one of these sheep. As the condition of the sheep in this group was poor and the weekly intake of cottonseed had declined during the previous three weeks, this treatment was terminated at the end of the eighth week.

In Group 3, one sheep died during the 13th week. Mean weight changes and mean clean fleece weights of Group 2 and the survivors of Group 3 did not differ significantly (Table 2). In calculating the clean fleece production during the period of the trial, it was assumed that the mean wool production from shearing in February to the start of the experiment was the same for both groups.

(b) Feed Intake and Digestibility

The mean daily intake of sheep in Group 1 offered 454 g per head of fuzzy whole cottonseed was 148 g per head over an eight-week period. During the last week of feeding, mean daily intake fell to 115 g.

Group 3 consumed the total amount of wheat given on all occasions, and the two-day rations were usually consumed within 30 min. *Group 2 usually ate at least 80% of its two-day ration within 40 min, and the remaining portion, which consisted mainly of cottonseed, was consumed during the following 8 h. Between the 14th and 16th week, residues were collected from Group 2; these consisted wholly of cottonseed, and were equivalent to 50 g per sheep per day for the two week period.

The results of the digestibility trial are included in Table 1. It has been assumed in calculating these results that the digestibility of wheat when given alone was the same as when given with cottonseed.

(c) Chemical and Post-Mortem Observations

In Group 2, those sheep which had maintained or gained body weight during the trial had a significantly ($P<0.05$) greater mean serum GOT level (1,680 units/ml) than those which lost weight (410 units/ml).
Of the five sheep examined post-mortem (180-3500 units GOT/ml) four had enlarged hearts and brick-red colouration of the kidneys. The only consistent histopathological finding was a mild to severe siderosis of the kidney.

The rumens of sheep in the group feeding experiment contained no whole cottonseeds, but many whole seeds were observed in the rumen, reticulum and omasum of sheep in the digestibility experiment.

IV. DISCUSSION

These studies showed that whole fuzzy cottonseed was unsatisfactory as a sole diet for survival of sheep. The mean daily digestible organic matter (DOM) intake of approximately 80 g per day was well below energy requirements, body weight loss was rapid (1 kg per sheep per week) and two of ten sheep died.

When sheep were fed 454 g per day of a diet containing equal quantities of cottonseed and wheat, they usually ate all the cottonseed, and the mean body weight at the end of 18 weeks was not significantly different from the mean weight of the sheep fed 454 g of wheat. Adding cottonseed to wheat reduced the rate of intake of wheat, and therefore may be of value in drought feeding when some sheep may not obtain sufficient grain and others may obtain too much and in consequence suffer digestive disturbances. The addition of cottonseed, although providing increased amounts of digestible crude protein, did not significantly increase clean fleece production.

The mean body weight changes in groups fed wheat and the cottonseed/wheat mixture were not well related to the calculated DOM intakes. These groups had similar weight losses yet the mean daily DOM intakes were 35 1 g for the group fed wheat and 297 g for the group fed the cottonseed/wheat mixture. The intake of the group fed wheat was a little below the maintenance requirement for a pen-fed sheep of 40 kg (Coop 1962). The DOM intake of the group fed the cottonseed/wheat mixture may have been underestimated as the sheep in the digestibility studies were one year old and development of their molar teeth may not have been sufficiently advanced for efficient mastication of the whole cottonseed. Whole seeds were found in the rumen, reticulum and omasum of these sheep but not in the digestive tracts of the adult sheep examined at Temora. In addition, the DOM of cottonseed will include considerable amounts of lipid and probably yields more energy to the animal than that of wheat.

There are few reports on the effect of gossypol on sheep, though Mickelsen and Young (1966) have stated that once appropriate microflora become established, ruminants appear to be immune to this substance. High serum GOT levels from sheep gaining weight when given wheat and cottonseed indicated an increased permeability of cell walls. However, histopathological examination did not associate these high levels with liver damage. The gossypol content of cottonseed is considerable (0.66%, A.O.C.S. 1962) and the enlarged hearts of four of the five sheep slaughtered could have been caused by its ingestion; Sharma, Smith and Clawson (1966) reported enlarged hearts in swine given diets containing lower levels of gossypol than were present in the diet of our sheep. Studies of the effects of gossypol and the cyclopropenol fatty acids of cottonseed on liver function, meat flavour and chemical composition of tissues have commenced using sheep fed mixtures of whole cottonseed and wheat.
V. ACKNOWLEDGMENTS

Thanks are due to Mr. D. Jenkins and Mr. A. Green who assisted in the supervision of the sheep during the digestibility trial, to Mrs. J. Rofe for the histopathological examinations, and to Mrs. L. Romalis for assistance in the chemical analyses.

VI. REFERENCES


