

# DIGESTIBILITY, CRUDE PROTEIN AND YIELD CHANGES IN MATURING GRASS-LEGUME HAY CROPS

J. C. RADCLIFFE\* and T. R. NEWBERY\*

## Summary

. **Herbage** samples were collected at weekly intervals from five Adelaide Hills grass-clover hay crops between early September and early December 1966. Percentage digestibility *in vitro* increased slightly during early spring to reach a maximum of 70% in mid-October and then declined. In the last four weeks, the rate of decline increased to 0.8% per day. The crude protein percentage declined at an approximately constant rate throughout the experimental period.

A decline in dry matter yield was also recorded during the last four weeks. Since this occurred concurrently with the decline in digestibility, there were losses from the sward of up to half of the digestible dry matter. It was observed that some farmers cut their hay crops after much of this loss had taken place.

## I. INTRODUCTION

Fodder conservation is widely practised in Southern Australia. It has been shown that the digestibility of perennials in summer growing season environments declines with advancing maturity (Pritchard, Folkins and Pigden 1963; Terry and Tilley 1964; Mowat et al. 1965; Heinemann and Evans 1965). However, many of the pastures in Southern Australia are dominated by annuals, and the maturity of these crops coincides with the end of the growing season.

It is now possible to measure the digestibility of large numbers of forage samples using the *in vitro* digestibility techniques suggested by Tilley and Terry (1963). The high correlation of this method with the more tedious *in vivo* techniques and its superiority to other *in vitro* or chemical analytical methods has been well established (Hi Kon Oh, Baumgart and Scholl 1966).

This paper records changes which occurred in the yield, dry matter digestibility *in vitro* and crude protein content in five Australian pastures during the spring growing season of 1966.

## II. EXPERIMENTAL

Five winter-grazed pastures composed of a perennial grass and Mount Barker subterranean clover (*Trifolium subterraneum* L.) were visually selected on a basis of minimum within-site variability from dairy properties in the Adelaide Hills. *Phalaris tuberosa* L. predominated in the Birdwood pasture. Perennial ryegrass (*Lolium perenne*, L.) was the principal grass in the two year old stand at Woodside, the three year old stand at Oakbank and the long established pasture at East Hahndorf. As the latter sward had been only lightly grazed it still

---

\*Northfield Research Laboratories, South Australian Department of Agriculture, Adelaide, South Australia.

contained dry residues from the previous season. The sward at West Hahndorf contained perennial ryegrass but was dominated by wild geranium (*Erodium cymosum*, Nees.)

At each site, a randomised block trial was laid out with six replications and fourteen harvest dates. The individual plots were 122 x 61 cm.

The pastures were closed to grazing at the end of August. Commencing September 6, 1966, one plot in each replicate was harvested from each experimental site every week. The fourteenth treatment was harvested on December 6, 1966. The harvests were made by cutting an area 91 x 30.5 cm. from the centre of each plot with hand sheep-shears. The fresh weights were determined and representative sub-samples were sorted by hand into clover, grass and weeds, and oven-dried overnight at 90°C. After weighing, the components were recombined and ground in a Wiley mill to pass a 1 mm screen.

Two stage *in vitro* digestibility analyses were made (Tilley and Terry 1963) using 48 h digestion times. The rumen liquor for all analyses was taken from one fistulated wether fed a constant diet of ryegrass-clover hay and starved for 20 h before sampling.

Crude protein analyses were made by Kjeldahl digestion (Jackson 1958) followed by analysis with a Technicon auto-analyser using alkaline phenate (200 g phenol and 200 g sodium hydroxide per l.), commercial sodium hypochlorite, "Teepol", 2N sulphuric acid and 1.76N sodium hydroxide as reagents.

The yields of total dry matter, digestible dry matter and crude protein were calculated.

### III. RESULTS

The botanical composition, dry matter digestibility and crude protein percentages of the five pastures at the start of the experiment are given in Table 1.

No statistically significant changes occurred in the botanical composition of the swards at Woodside, Oakbank or East Hahndorf during the experimental period. At Birdwood, the clover content increased to 26% of the dry matter yield on November 8, 1966, and then declined to 10% at the end of the season as the proportion of later maturing *Phalaris* increased. The proportion of clover

TABLE 1  
**Mean composition of five Adelaide Hills perennial grass-subterranean clover pastures, September 6, 1966**

Site	Percent of Dry Weight			Digestibility %	Crude Protein %
	Clover	Grass	Weeds		
Birdwood	19	61	20	63	25
Woodside	39	40	21	63	23
Oakbank	44	51	5	69	26
East Hahndorf	17	78	5	62	15
West Hahndorf	28	15	57	58	18

at West Hahndorf increased throughout the season. At the final harvest, the weed fraction, dominated by the early maturing wild geranium, constituted only 25% of the total yield.

The mean weekly results for yield of dry matter, digestible dry matter and crude protein, and for digestibility and crude protein percentage are shown in Figure 1 for the **Oakbank** pasture. The protein percentage decreased as the season progressed. By contrast, the digestibility percentage increased for the first six weeks and then declined. The rate of decline averaged 0.9 digestibility units per day over the last four weeks.

Despite their different botanical compositions, the other four swards gave results similar to those shown in Figure 1. During the last month of the experiment, the digestibility declined by 0.7 units per day at **Birdwood** and **Woodside**, and by 0.8 units per day at **East** and **West Hahndorf**.

The significant decrease in total dry matter yield recorded at **Oakbank** at the end of the season was also found at the other sites. Since these dry matter losses coincided with declining digestibility percentages, sharp reductions in the yield of digestible dry matter were recorded. The decline in digestible dry matter at **Oakbank** from 4780 kg/ha on November 8 to 2600 kg/ha on December 6 represents

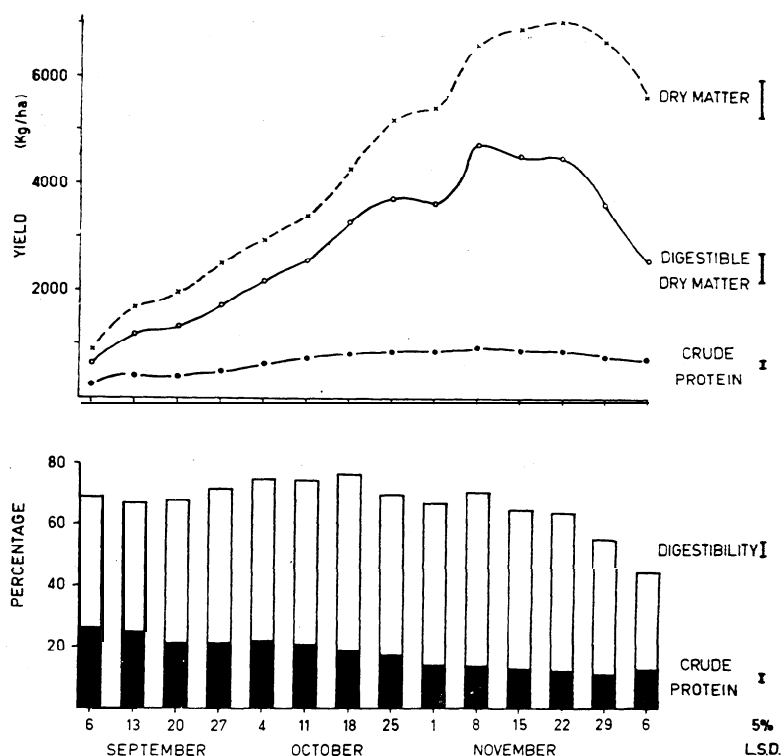


Fig. 1.—Yield of dry matter, digestible dry matter and crude protein, and the digestibility and percent. crude protein of a perennial ryegrass—subterranean clover pasture at Oakbank in the thirteen week period commencing September 6, 1966.

a loss of 46% of the total digestible dry matter from the sward. The losses recorded at other sites were 37 % at East Hahndorf, 4 1% at Woodside, 53 % at Birdwood and 57% at West Hahndorf.

#### IV. DISCUSSION

The data in Figure 1 **confirm** that crude protein results are of little' use in evaluating the **dry** matter digestibility of pasture (Raymond 1959).

It is suggested that the initial increase in digestibility observed over the first six weeks of the experimental period arose from selective grazing by the animals of the more digestible components of the sward, thereby leaving a residue of lower digestibility at the **start** of the experiment. As the pastures grew, this residue became a progressively less significant proportion of the **total** forage crop, leading to an overall increase in digestibility of the sward.

A decrease in the rate of production of digestible dry matter in late October is evident in Figure 1, and was also observed at the other sites. These **decreases** corresponded to a period of moisture stress. In the week ending November 1, each site received approximately one **inch** of rain which significantly increased the yields of digestible dry matter.

The decline in digestibility of 0.7 to 0.9 percentage units per day over the last month of the growing season was higher than that recorded by other workers. In the period mid June. to mid July in Ontario, using the **in vitro** technique, Pritchard, Folkins and Pigden (1963) recorded declines of 0.5 units per day, and Mowat *et al.* (1965) found values varying from 0.38 units per day for **brome**-grass to 0.54 units per day for cocksfoot. Minson, Raymond and Harris (1960) had earlier recorded declines in **ryegrass** in Great Britain at the rate of 0.5 units per day using the **in vivo** technique.

It is unlikely that the very substantial losses of dry matter from the pastures were solely physical losses. It has been shown (Wood and Petrie 1938) that increasing soil moisture stress initially leads to an increased respiration rate, and only after prolonged soilmoisture stress does the respiration rate fall.' It has been shown for some species that the rate of photosynthesis falls at temperatures above 30°C, (Verduin and Loomis 1944), while even small moisture stresses can reduce photosynthesis (Baker and Musgrave 1964). Henckel (1964) indicated that developing plants are more susceptible to moisture stress than plants in the vegetative stage of growth. As both the higher seasonal temperatures and moisture stresses occurred at the time the pasture reached maturity, it is probable that a concurrent increase in respiration and decrease in photosynthesis resulted in a net loss of dry matter from the pasture.

The practical consequences of the sharp declines in both digestibility and yield of digestible dry matter become obvious when the time of haymaking is examined. Three of the farmers cut their hay crops close to the maximum yield of digestible dry matter, which was observed to be at the commencement of flowering of the perennial ryegrass. The other two crops had lost nearly one-fifth of their digestible dry matter yield before the haymaking process began.

Although haymaking is necessarily controlled by weather conditions, farmers waiting a few extra days for ideal haymaking weather may harvest feed of lower digestibility containing smaller amounts of digestible dry matter than those who risk damage in the bale by cutting earlier under less favourable climatic conditions. A two week delay during the period of rapid decline in digestibility could result in a loss of up to half the digestible dry matter from the stand. The hay subsequently produced could be of such low digestibility that animal intake might be seriously restricted.

## V. ACKNOWLEDGMENTS

Grateful acknowledgement is made to Dr. W. G. Allden for helpful advice and criticism and to Mrs. D. B. Rundle for carrying out chemical and statistical analyses. Experimental sites were made available through the co-operation of Messrs. K. Oster, T. E. Downer, A. V. Kemp, A. T. Braendler and C. T. Dolling.

The work was supported by a grant from the Australian Dairy Produce Board.

## VI. REFERENCES

- BAKER, D. N., and MUSGRAVE, R. B. (1964). *Crop Sci.* 4: 249.
- HEINEMANN, W. W., and EVANS, D. W. (1965). *Proc. 9th int. Grassld. Congr.*, Sao Paulo, Brazil. p. 887.
- HENCKEL, P. A. (1964). *Ann. Rev. Plt. Physiol.* 15: 363.
- HI KUN OH, BAUMGART, B. R., and SCHOLL, J. M. (1966). *J. Dairy Sci.* 49: 850.
- JACKSON, M. L. (1958). "Soil Chemical Analysis". (Constable: London.)
- MINSON, D. C., RAYMOND, W. F., and HARRIS, C. E. (1960). *J. Br. Grassld. Soc.* 15: 174.
- MOWAT, D. N., FULKERSON, R. S., TOSSELL, W. E., and WINCH, J. E. (1965). *Proc. 9th int. Grassld. Congr.*, Sao Paulo, Brazil, p. 801.
- PRITCHARD, G. I., FOLKINS, L. P., and PIGDEN, W. J. (1963). *Can. J. Plant Sci.* 43: 79.
- RAYMOND, W. F. (1959). In "The Measurement of Grassland Productivity". *Proc. 6th Easter School agric. Sci., Univ. Nott.* (Butterworths: London.)
- TERRY, R. A., and TILLEY, J. M. A. (1964). *J. Br. Grassld. Soc.* 19: 363.
- TILLEY, J. M. A., and TERRY, R. A. (1963). *J. Br. Grassld. Soc.* 18: 104.
- VERDUIN, J., and LOOMIS, W. E. (1944). *Plant Physiol.* 19: 278.
- WOOD, J. G., and PETRIE, A. K. (1938). *Ann. Bot., Lond. (N.S.)* 2: 729.