# APPLICATION OF INTRARUMINAL CHROMIUM CONTROLLED RELEASE CAPSULES TO THE MEASUREMENT OF HERBAGE INTAKE OF SHEEP AT PASTURE

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# ABSTRACT

Experimental evidence obtained since 1950 suggests that New Zealand sheep farm production and financial returns could be increased by adopting separate grazing management for ewes of different pregnancy and rearing status from 6 weeks before lambing until weaning. Progress in developing management systems for the differential allocation of pasture, favourable lambing paddocks and labour during this period has been restricted by the absence of equipment for diagnosing ewe pregnancy status and a lack of data relating pasture conditions to feed intake and ewe and lamb productivity. Accurate pregnancy diagnosis by realtime ultrasound scanning has been available to farmers since 1985, but research into ewe grazing management continues to be hampered by the absence of techniques for measuring feed intake. This thesis addressed the latter issue, first by validating controlled release capsule (CRC) technology for measuring feed intake and second by examining feed intakes of ewes differing in pregnancy and rearing status and relating intakes to productivity.

A series of 11 experiments were conducted with sheep CRC to validate this technology for measurement of intake and to develop appropriate systems for using the technology in experimental situations. These studies examined: the linearity and period of $Cr_2O_3$ release; the effect of presence of capsules in the rumen on voluntary feed intake; the effect of feed type and feeding level on $Cr_2O_3$ release rate; and the accuracy of faecal $Cr_2O_3$ concentration in predicting faecal output of sheep dosed with CRC when alternative sampling regimens were applied. These experiments, conducted under both indoor feeding and outdoor grazing conditions, established that CRC released $Cr_2O_3$ into the rumen in a uniform manner once initiation of matrix extrusion had been completed 2 to 3 days after capsule insertion. The subsequent period of linear release (25 to 100 days) was found to be primarily dependent upon characteristics of the capsules controlled at manufacture (i.e. orifice diameter, matrix composition and length of pressed tablet matrix core). In comparison, environmental factors, both within and outside the sheep, had relatively small effects on the rate or linearity of $Cr_2O_3$ release. Release rate decreased by c. 4% if daily feed intake was at 0.7 maintenance compared to an ad libitum level, increased by c. 2% if hay rather than fresh pasture was consumed and decreased by 10 to 13% if capsules were placed in rumen-fistulated sheep rather than in intact animals. Adoption of feeding level below 0.6 maintenance for 4 to 7 days reduced $Cr_2O_3$ release rate and could cause capsule failure. Between-capsule variation in release rate from CRC recovered from the rumen by slaughter was low (coefficient of variation 2.0 to 6.5%). Variation between capsules within sheep was usually lower still. Voluntary herbage intake was significantly reduced if sheep were dosed with prototype CRC with inflexible wing designs. Under indoor conditions, correlations of 0.90 to 0.99 between daily faecal output derived by $Cr_2O_3$ dilution and actual faecal output for individual sheep were obtained. The correlation between estimates of mean 3-day faecal output of sheep at pasture predicted from the $Cr_2O_3$ concentration in morning and evening grab samples and from total collections was 0.87.

Prediction of individual animal intakes (indoors) appeared less accurate ($r=0.74$) because of variation in capsule release rate and in the animal's own ability to select and digest its diet. Group mean estimates, which are appropriate for practical grazing conditions, were usually within $\pm 10\%$ of the actual value. Low diurnal variation in faecal $Cr_2O_3$ concentration (non-significant) allowed flexible faecal sampling regimens to be applied. In summary CRC were demonstrated to be superior to existing feed intake measurement techniques and to be well suited to the estimation of mean intakes of sheep, provided that suitable faecal sampling regimens were applied.

A pilot study investigating the feed intakes and productivity of ewes of different pregnancy and rearing status indicated that intakes of twin-bearing ewes were reduced in comparison to those of single-bearing ewes during late pregnancy, when the two groups were grazed together under "commercial" farming conditions. During lactation, intakes exhibited a curvilinear relationship with time and were generally higher (by up to 32%) in twin-rearing ewes than in single-rearing ewes. This pattern of feed intake was less clear in a subsequent nine-week lactation study. In that trial, experimental groups comprising equal numbers of ewes rearing single or twin lambs were continuously grazed on five different pastures maintained at fixed sward surface heights (2.5, 4.0, 6.0, 7.0 and 9.0 cm). Herbage intakes by both single- and twin-rearing ewes were maximised at a sward surface height of approximately 5.0 cm (1000 to 1100 kg dry matter/ha). Lamb growth rates were not affected by sward height during the first six weeks of lactation because the ewes mobilised body reserves to maintain milk production. All ewes lost liveweight during the first 6 weeks of lactation but only the ewes on the 2.5 cm sward failed to regain lost liveweight from weeks 6 to 9 of lactation. Wool production, strength and colour were not affected by sward conditions in either the ewes or lambs over the lactation period. These results suggest that New Zealand farmers would gain little benefit from differential management of ewes post-lambing where a minimum grazing height of 5.0 cm could be maintained provided that ewes were in good condition (i.e minimum condition score 3.0) at lambing.

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# ABBREVIATIONS

| | |
|---|---|
| AA | atomic absorption spectrophotometer |
| ANOVA | analysis of variance |
| c. | circa (approximately) |
| CIDR | controlled internal drug release device |
| Cr | chromium (III) |
| $Cr_2O_3$ | chromium sesquioxide |
| CRC | controlled release capsule |
| CS | condition score |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| cv. | cultivar |
| d | day |
| DM | dry matter |
| DMD | dry matter digestibility |
| DMI | dry matter intake |
| DOMD | digestible organic matter in the dry matter (D-value) |
| DOMI | digestible organic matter intake |
| DSIR | Division Scientific and Industrial Research |
| EPM | Ellinbank pasture meter |
| F.O.B. | free on board |
| h | hours |
| ha | hectare |
| HFRO | Hill Farming Research Organisation (Scotland) |
| ICPES | Industively coupled plasma emission spectrophotometry |
| L | lactation |
| M | maintenance |
| MA | mixed age |
| min. | minute |
| MJME | megajoules of metabolisable energy |
| NHA | net herbage accumulation |
| NA | not applicable |
| N/ktex | Newtons per kilotex |
| OM | organic matter |
| OMD | organic matter digestibility |
| OMI | organic matter intake |
| P | pregnancy |
| RDM | residual dry matter |
| RH | relative humidity |
| RMT | rumen mean retention time |
| X | tristimulus value (red) |
| Y | tristimulus value (green) |
| Z | tristimulus value (blue) |

**Weights, volumes and measures**

| | |
|---|---|
| µg | microgram |
| mg | milligram |
| g | gram |
| kg | kilogram |
| ml | millilitre |
| nm | nanometre |
| µm | micrometre |
| mm | millimetre |
| km | kilometre |
| mA | milliamp |
| $^oC$ | degrees centigrade |

**Statistical terms**

| | |
|---|---|
| CV | coefficient of variation |
| df | degrees of freedom |
| n | number |
| r | correlation |
| RSD | residual standard deviation |
| SD(s) | standard deviation |
| sem | standard error of the mean |
| TSS | total sum of squares |
| var | variance |
| $\bar{x}$ | mean |
| NS | not significant |
| + | significant at $P < 0.1$ |
| * | significant at $P < 0.05$ |
| ** | significant at $P < 0.01$ |
| *** | significant at $P < 0.001$ |