# Paper 9
# NUTRITION OF RUMINANTS GRAZING LUCERNE

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## LUCERNE IN THE FARMING SYSTEM

The agronomic advantages of lucerne feature on the well-drained pumice soils of the Central Plateau in the North Island, and the stony alluvial soils of Canterbury (Stewart, 1967). The excellent match between the growth pattern of lucerne and the requirements of spring calving dairy cows has resulted in major increases in milk output in the Rotorua-Taupo district (Mace and Peterson, 1979). There, farmers increased the area of lucerne from 14 to 53% of their properties, concomitant with an intensive MAF advisory scheme. With sheep systems, at least in the North Island, farming predominantly on lucerne is not popular, even though farmlet studies show the problems of poor winter growth, persistence and delayed spring feed supply can be successfully accommodated by including grasses (Vartha and Fraser, 1978; Fraser and Vartha, 1980; Mace, Paper 12). Where the crop has no major agronomic advantage the proportion of lucerne on a farm should only be about 15% (Jagusch *et al.*, 1980). The use of lucerne for growing out cattle has also similar limitations as above (Croy and Weeda, 1975), together with the competitive interests of other classes of stock, conservation, and the possibility of bloat (A.M. Nicol and T.F. Reardon, pers. comm.).

The complimentarity of lucerne's nutrient profile (protein, amino-acids, minerals, vitamins) to that of grain was noted by Coop (1967) and has been tested successfully with early and late weaned lambs in New Zealand (Jagusch and Bell, 1979); however, feedlot finishing is unlikely to contribute significantly to our animal agriculture (Jagusch and McIvor, 1974).

Experience with "all lucerne" farms shows reduced life of stands through over-grazing in winter and set stocking in spring (Topp, 1965). More ideal grazing management could require lucerne be spelled over late winter-early spring (Janson, 1974) and otherwise rotationally grazed after 35-40 day rest periods (Iverson, 1965). The grazing period and the consequent number of paddocks required has raised certain contention. O'Connor (1970) recommended a 4-paddock system, the Ashburton FAO team 12 paddocks, and Jagusch *et al.* (1980) 15 paddocks. This area is reviewed by Janson (Paper 11).

## LUCERNE AND REPRODUCTION

Coumestrol and 4 meth-oxycoumestrol, collectively called coumestans, are the oestrogens synthesised in lucerne that depress ovulation rate in ewes (Kelly and Lindsay, 1975; Kelly *et al.*, 1976). Fungal foliar disease is a major cause of coumestan synthesis (Francis and Millington, 1965; Bickoff *et al.*, 1967), this being the plant's reaction to infection through the synthesis of phytoalexins (Ingham and Millar, 1973). Selection against foliar disease reduces coumestan levels and lucerne kept free of disease by growing in aseptic conditions (Stuthman *et al.*, 1966; 1967) and after fungicide treatment (Hanson *et al.*, 1965) has low coumestan levels. In the field at Ruakura we have had problems controlling all fungi using a combination of Benlate (benomyl 50) and Manzate 200 (Mancozeb 80), but effective control has been obtained at Wairakei Research Station near Taupo (K.T. Jagusch and E. McKenzie, unpublished).

Loper (1968) and Kain and Biggs (1981) have shown elevated coumestans in plants severely infested with aphids. Nielson and Don (1974) believe aromatization can occur in response to stylet probes and salivation of insects, thus stimulating phytoalexin synthesis. They suggested such synthesis is faster in resistant plants than susceptible ones.

Kain and Biggs (1981) maintain sampling only leaf for coumestan analysis over-estimates the importance of fungal infection but under-estimates the importance of aphid infestation. At Ruakura we have been unable to demonstrate a clear aphid effect (aphids at 100/stem) in the absence of fungi. At Wairakei stands sprayed with aphicide and fungicide have no coumestans, but those sprayed only with aphicide do. At this station the main fungus has been *Pseudopeziza medicaginis* (common leaf spot) (E. McKenzie, pers. comm.).

Smith (J.F.) *et al.* (1979) found flushing ewes on lucerne regrowth kept disease-free for 20, 35 and 50 days, and on mature lucerne-prairie grass stands containing no coumestans, increased multiple ovulations by 6% for each 1 kg liveweight gain. On the other hand, catastrophic losses of multiple ovulation were obtained when ewes were flushed on oestrogenic stands infected largely with *Pseudopeziza*. In this experiment coumestan concentrations in leaf samples reached 500-600 ppm in paddocks used pre-mating and reached over 200 ppm during mating.

In the same environment we find the regrowth from closely grazed stands sprayed with mixed fungicide at 12 day intervals can be made into non-oestrogenic pellets, but pellets from ungrazed non-sprayed stands contained 98 ppm coumestans. All lucerne was sprayed with aphicide. Feeding such pellets to sheep at the rate of 1.5 kg/head/day mimicked the results obtained in the field; the degree of depression in ovulation rate being directly related to oestrogen levels in the ration (Smith (J.F.) *et al.*, 1979).

These data confirm previous grazing trials showing reduced ovulation rates and twinning when ewes are flushed on lucerne (Coop and Clarke, 1960; Thomson and Jagusch, 1976; Coop, 1977; Scales *et al.*, 1977) and experimental variations probably result from the failure to recognise the degree of fungal infection and possible aphid infestation usually associated with the grazing of mature stands. It is noteworthy that hard grazing not only removes fungal inoculum, but also controls aphids (Smallfield *et al.*, 1980). It appears coumestans interfere with normal hormonal inter-relationships between the pituitary and the ovaries through inhibition of gonadotropin release (Kelly *et al.*, 1976; Leavitt and Wright, 1965). Suppressed ewes respond dramatically to ovarian stimulation by pregnant mare serum (Smith (J.F.) *et al.*, 1979) and full recovery is obtained 2 weeks after taking ewes off coumestan-rich lucerne (Smith (J.F.) *et al.*, 1980). However feeding coumestan-rich pellets 7 days prior to a synchronised oestrous suppresses ovulation rate.

With recipient cattle fed coumestan-rich lucerne silage and hay, fertilised egg transfers have been unsuccessful (Animal Health Laboratory, Ruakura, pers. comm.).

## SODIUM DEFICIENCY IN LUCERNE

Minimum concentrations of sodium for satisfactory nutrition of grazing ruminants fed mixed pasture are: sheep 0.07, beef animals 0.10, and dairy cows 0.20% DM respectively (National Research Council, 1957, 1963, 1966). Low sodium levels in New Zealand pasture are characteristic of the land-locked areas of the Central Plateau and Central Otago; also Nelson and inland Canterbury. Generally speaking, variability throughout the country reflects pasture composition including weeds, distance from the sea and prevailing winds, and potassic fertiliser usage (Smith (G.S.) *et al.*, 1978a, b). In contrast to natrophillic ryegrass and white clover, lucerne is a natrophobe, concentrating sodium in its roots rather than aerial parts (Smith (G.S.) *et al.*, 1980a, b). Lucerne grown in these areas therefore, is likely to be very low in sodium, as evidenced by the data of Joyce and Brunswick (1975a).

On the Central Plateau substantial animal production responses have been obtained with lambs, young cattle, and lactating dairy cows (Joyce and Brunswick, 1973; 1975a, b). Lucerne on the pumice soils of the Rotorua-Taupo region contains only 0.03% sodium and responses to salt drenches, licks and sprays are equally efficacious, whereas composite mineral mixes without sodium gave no response.

A severe growth check by lambs given lucerne which had been sprayed with paraquat to remove weeds, in Canterbury was described by Jagusch *et al.* (1976a) as follows: "after weaning lambs developed a 'pica' for soil, which began with their consuming weeds and grasses around the fence lines, then seizing soil in what appeared to be an avid craving for plant roots in areas adjacent to the fence line, but also in discrete areas of about 1 $m^2$ in the paddock". The authors suspected sodium deficiency and obtained significant responses when lambs on pure stands were given salt licks, but differences were not as regular or spectacular as on the Central Plateau (Jagusch *et al.*, 1976b). The results of Scales (1976) would suggest no sodium deficiency in lucerne grown in Canterbury, but unpublished data by the same author show positive responses in Central Otago.

It can be recommended that lucerne-fed animals be supplemented in known sodium-deficient areas, particularly those where potassic fertiliser has been regularly applied (McNaught, 1959). Magnesium can also occur in low amounts with sodium, and although responses to supplementation were negligible in lambs (Rattray, 1978), dairy cows, particularly when under-fed, may find the combination of sodium and magnesium critical (Young *et al.*, 1981).

## NUTRITIVE VALUE OF LUCERNE

The gross chemical composition of grazed lucerne according to stage of growth, has been recorded by Bailey *et al.* (1970), Joyce *et al.* (1972) and Jagusch *et al.* (1976a). The ratio of stem to leaf increases as the plant matures and the associated chemical changes result in dramatic decreases in digestibility (Fletcher, 1976). The magnitude of this decrease is particularly high in summer and autumn (Fletcher, 1976), and with fungal infected plants through leaf senesence (Jagusch *et al.*, 1980). However leaf digestibility remains constant at all stages of regrowth (Thom, 1978).

The major minerals (Ca, P, Mg, Na, K) have been measured in lucerne grown on the Central Plateau (Joyce and Brunswick, 1973), Canterbury (Jagusch *et al.*, 1976b) and Waikato (Thom and Smith, 1980), according to stage of growth. Early regrowth has the highest concentration of minerals. Additional value for Se, Cu, S, Co and Cl are recorded in Canterbury.

When using sodium supplementation where necessary, the true nutritive value, referred to as feeding value by Ulyatt (1978), is determined by animal utilisation of the lucerne each grazing (Joyce and Brunswick, 1977; Bryant, 1978; Thomson, 1978; Reardon and Brunswick, 1979; Jagusch *et al.,* 1979a, b; 1980; 1981; Reardon, 1980). Increasing utilisation per grazing results in progressively lower intakes of poorer quality feed, and from these experiments precise curvilinear relationships between animal production and lucerne allowance (kg DM/head/day) can be determined. Grazing regrowth earlier also gives an improvement in nutritive values, but this is not always compatible with high lucerne production (Weeda and Croy, 1976; Jagusch *et al.,* 1980; Janson, Paper 11).

## LUCERNE FOR EARLY WEANING

Lambs can be successfully weaned onto lucerne at 4-6 weeks of age (Jagusch *et al.,* 1970; McConnell and Jagusch, 1972; Fennessy *et al.,* 1972; Mitchell and Jagusch, 1972; Rattray *et al.,* 1976). Problems arise only if the lambs are too young (< 4 weeks) or too light (< 12 kg) (Jagusch, 1976). This relates primarily to reticulo-rumen capacity (Rattray *et al.,* 1976). It is the author's contention that lambs should not be early weaned in wet years and when the DM content of the lucerne is low. Practical recommendations for early weaning onto lucerne are presented by Jagusch (1976).

## LUCERNE SILAGE AND PRESSED LUCERNE

The high protein and relatively low concentration of soluble sugars in lucerne (Bailey *et al.,* 1970) make it essential to wilt silage so osmotic concentrations are increased, giving focal points for lactobacilli fermentation (Dougherty, 1973). Wilted silage is higher in lactic acid and has less volatile fatty acids than high moisture silage, and is eaten more readily by stock (Joyce and Brunswick, 1975a; Lancaster and Rattray, 1976). The higher dry matter intake and gains in cattle fed formate-treated, high-moisture lucerne silage was attributed to limited fermentation and less organic matter nutrient losses (Lancaster *et al.,* 1975). Additives decrease protein degradation and organic acid fermentation but are not necessary when lucerne is wilted (Scales and Barry, 1975).

The extraction of leaf protein concentrate and the use of the pressed residue which amounts to 60-70% of the crop (Allison and Vartha, 1973) with a digestibility of 70% (Vartha and Allison, 1971), for ruminant animals could be the most biologically efficient way to use lucerne (Vartha *et al.,* 1973). Pen feeding trials associated with these experiments showed sheep performed equally as well on pressed lucerne as they did given lucerne hay. The integration of sheep production with protein extraction on all lucerne farms has merit because animal requirements of the breeding flock are low when lucerne growth under irrigation is high and stocking rates could be maintained by feeding pressed lucerne in summer and winter (Jagusch, 1975). Favourable production has also been obtained with steers fed pressed lucerne in comparison with fresh material (Trigg, 1980). Equal or greater efficiency could relate to higher intakes associated with both maceration and less N to excrete. However lactating dairy cows offered pressed lucerne suffered reductions in milk production of 15% together with depressed fat and protein tests (Trigg, 1980). Soluble carbohydrate and mineral supplementation did not improve intake or production. It is suspected the extraction process removes a specific fraction of N (eg. highly soluble N or available amino acids) which in combination with a lower digestibility and a relative Mg deficiency causes the reduction in milk production (Trigg and Bryant, 1978).

## CONCLUSION

Best performance can be expected from lucerne where it has agronomic advantages over conventional swards and produces more DM/ha; when it is free of oestrogenic coumestans, and where necessary it is supplemented with salt. Lambs and steers grow well provided they are not forced to eat more than 40% of the lucerne present pre-grazing. In addition lucerne has high nutritive and feeding value; it can readily be conserved, and in future could be easily integrated with protein extraction systems.

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## DISCUSSION

Q. What form of salt can be used?

Jagusch: Licks, granules, drenches and sprays are equally advantageous.

Q. How would you suggest embryonic loss be avoided?

Jagusch: Do not change the level of nutrition too dramatically after tupping; just ease off into mid-pregnancy feeding regime of restricted nutrition.

Vartha: At Kirwee we could get 140% lambing, tupping on lucerne at maintenance +25%, then dropping to 66% of maintenance.

Q. Is selenium given?

Jagusch: Selenium is given routinely in all trials, usually in a worm drench.

Nicol: Does the level of coumestan enhance growth rate?

Jagusch: Yes, and increases the tenderness and flavour of the meat. However, we find in the grazing situation the coumestan effect on growth rate is cancelled by fungal-infected lucerne having a lower leaf/stem ratio. The positive responses have been recorded with feedlot lambs.

Middleton: If lucerne with fungal infection on the leaves is made into hay, is the material still oestrogenic?

Jagusch: Yes.

Ensign: What stage of maturity would you recommend grazing?

Jagusch: The likelihood of leaf disease is lessened if young, fresh regrowth is grazed at flushing and mating time. At other times of the year graze at 10% flower and/or as recommended by agronomists.

Brosnan: Is there embryonic loss associated with feeding lucerne?

Jagusch: Oestrogenic lucerne depresses ovulation rate, but may not influence embryonic loss. Fertilised eggs transferred to female recipients fed oestrogenic hay have not implanted successfully. Under natural mating conditions, embryonic losses additional to depressed ovulation rate, have not been recorded.