DECISION SUPPORT TOOLS TO OPTIMISE CONVERSION OF PASTURE TO MILK

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SUMMARY

This paper examines the logic behind the efficient feeding of grazing dairy cows with the objective of improving on-farm productivity. Efficient utilisation of feeds by grazing dairy cows requires a detailed knowledge and understanding of feed budgeting principles, based on an understanding of seasonal pasture growth and pasture accumulation rates, nutritive characteristics of the pasture consumed, relationships between allowance of pasture and pasture intake, and interactions between pasture and supplementary feeds. Decision support tools that assist in making complex operational decisions to more efficiently feed grazing dairy cows have been briefly reviewed.

Keywords: Decision Support tools, grazing dairy cows, pasture intake, nutrient intake

INTRODUCTION

The dairy industry is one of Australia's principal rural industries, with a post-factory output estimated at over $9 billion in 2001/2002 (ADC 2002). Over 55% of Australia's milk is converted to export products, amounting to about 16% of world trade in dairy products (ADC 2002). Of this export trade, at least 62% of total milk, and about 85% of dairy exports come from Victoria (ABS 2002). Milk production in Victoria has grown at about 6% per year, with most of the increase contributing to export growth. However, efficiency gains in the decade from 1989/90 to 1999/00 from technological improvements and the adoption of better farming methods, termed 'total factor productivity', has been 1.2 % (ABARE 2001), suggesting that improvements in production have been closely linked to increasing inputs. At the same time, the decline in 'terms of trade' (the ratio of prices received by dairy farmers for their products to prices paid for inputs) has been modest at –1.3% (ABARE 2001), and the decline in terms of trade may accelerate in the future. This scenario indicates that farmers need to improve efficiency to remain profitable.

Pasture makes up approximately 80% of the metabolisable energy (ME) intake of dairy cows (ADC 2002), however, this varies markedly between farms (25-100%, Armstrong *et al.* 1998). Since 1982, the amount of concentrate supplements fed to dairy cows has increased from about 0.2 t/cow/year to 0.6 - >2.0 t/cow/year (Doyle *et al.* 2000), and feed costs contribute around 80% of variable costs on an average dairy farm (Armstrong *et al.* 1998). The increased use of supplements in grazing systems presents unique challenges in optimising pasture and supplement conversion into milk to remain profitable. Advisers and consultants to dairy farmers are increasingly expected to provide advice to farmers on the economic consequences of different feeding systems. This requires knowledge of feed budgeting principles, including pasture accumulation rates under grazing, limitations to pasture growth, the nutrients cows obtain from different feeds, the nutrient requirements for different levels of production and the interactions between feeds. The complexity of the dynamic interactions between cows, pastures and supplements makes feed budgeting difficult.

Increased feeding efficiency has marked effects on on-farm operating profit. W.J. Fulkerson (*pers. comm.*) found that providing dairy cows with their exact daily energy requirements spared pasture and improved production by 10%. On a farm producing 1 million litres of milk per year, it was calculated that the pasture spared by using this feed allocation method could be converted into more than 89,000 litres of extra milk, or around $26,700 of extra revenue.

This paper briefly reviews the knowledge required, and the tactical decision support tools that are available, to assist Australian dairy farmers and their advisers in making feeding decisions in situations where pasture constitutes a large proportion of feed inputs.

PASTURE ACCUMULATION UNDER GRAZING

Efficient management of the growth and utilisation of pasture involves striking the right balance between animal feed requirements and the seasonal and annual fluctuations in pasture production. It is generally accepted that 3 types of feed plan are required (Milligan *et al.* 1987), namely:

1. A feed profile that is a long term strategic plan (annual) for making decisions on stocking rate, time of calving, the likely need for forage conservation and supplementary feeds;
2. A feed budget that is a medium term tactical plan involving decisions on how to use a pasture surplus or overcome a pasture deficit, and
3. A grazing plan, involving operational decisions on allocating pasture to cows in strip grazing or small paddock rotation systems.

All of these plans involve the ability to calculate nutrient requirements of cows and those supplied by pasture, conserved fodder or concentrate supplements.

Dairy farmers need to have an understanding of seasonal pasture growth and pasture accumulation rates that are relevant to their farm to effectively apply feed profiling and feed budgeting principles. Perennial pasture growth rates have been measured under a range of conditions throughout the dairying regions of Victoria (Stockdale 1983; Doyle *et al.* 2000), and the Victorian Department of Primary Industries is currently developing a database to collate existing pasture growth rate data. Similar databases are being created for other dairy regions in Australia. While these data provide average values, local factors such as climate, soil fertility, pasture species and grazing management will have a large affect on overall pasture availability. As such, pasture accumulation is the most variable component of feed budgeting, and it is essential that farmers monitor and record pasture accumulation to optimise cow performance and system efficiency. In Victoria, the Target 10 program and others provide services to dairy farmers to improve feed profiling and feed budgeting skills, but there is limited evidence that farmers formally record pasture cover or accumulation rates. One approach to improving the overall use of pasture and brought in feeds to improve farm productivity is to understand the reasons for poor adoption and to develop user-friendly ways of measuring pasture mass.

NUTRIENTS IN PASTURE

Effective use of supplements to provide nutrients that are limiting the performance of lactating cows is dependent upon knowledge of the nutrient concentrations of pasture consumed. It is currently not feasible to routinely analyse the nutrient content of pasture being grazed in strip grazing systems because of turnaround time and other logistical issues. Databases of nutritive characteristics of pasture can help overcome these constraints by enabling prediction of the nutritive characteristics of pasture consumed by grazing cows.

By the mid 1990's, a reasonable amount of information had been collected on the DM intake of grazing cows in relation to pasture allowance and pasture mass (Holmes 1987; Doyle *et al.* 2000; Stockdale 2000). However, there was little quantitative information on the nutrients in the herbage consumed by grazing cows. Since then, selection differentials (correction factors for adjusting nutrient concentrations of pastures cut to ground level to that consumed by grazing cows), for ME, crude protein (CP) and neutral detergent fibre (NDF) have been reported for cows grazing perennial pasture in Victoria (Wales *et al.* 1997, 1998, 1999; Dalley *et al.* 1999; Jacobs *et al.* 1999; Stockdale *et al.* 2001) and New South Wales (Kellaway *et al.* 1993).

The available information from research and on-farm monitoring has been compiled into a database on nutrient concentration in perennial pastures and in the material selected by grazing cows (Cohen and Doyle 2000). Continued additions of data to this database mean that it now contains over 15,000 individual descriptions for perennial pastures in Victoria (see www.target10.com.au). Results from searches within the database provide estimates of the nutritive characteristics of pastures consumed in the northern irrigation, south west and Gippsland regions of Victoria, based on month, pasture mass and descriptions of botanical composition.

In northern Victoria, annual pastures comprise, on average, 25% of the pasture area on irrigated dairy farms (Armstrong *et al.* 1998), and this may increase as the price and availability of irrigation water change. The available information on nutritive characteristics of annual pastures has also been compiled into a database (Heard *et al.* 2002). The number of entries is significantly less than that of the perennial pasture database (approximately 780 entries), but will be continually updated as new data become available.

NUTRIENTS IN SUPPLEMENTS

Concentrate and conserved forage supplements also vary in nutritive characteristics. Data from analyses in NSW are available on the state government database at www.agric.nsw.gov.au/feedbase, while data from analyses at Feedtest® in Victoria are available on www.dpi.vic.gov.au/farming/dairying. In addition, nutrition models, such as GrazFeed (Freer *et al.* 1997), CAMDAIRY (Hulme *et al.* 1986) and Diet Check (Heard *et al.* 2004) contain information on the nutritive characteristics of supplements offered to dairy cows in Australia. In the case of supplements, it is advisable for farmers to have samples of the forage they conserve or purchase, and brought in supplements, analysed for nutritive characteristics given the variation between material from different sources.

PREDICTING PASTURE INTAKE

Estimating the amount of pasture consumed by a grazing dairy cow is difficult. Characteristics of pasture such as pasture mass, sward composition, digestibility, nutrient concentrations and grazing management will all influence pasture intake (Doyle *et al.* 2000), as will other factors such as liveweight, body condition, stage of lactation, amount of supplement consumed and genetic potential for producing milk. While the pasture consumed by dairy cows in strip grazing or small paddock rotation systems can be estimated from pre and post-grazing pasture mass, it has proved difficult to get the majority of farmers to adopt this approach.

A series of experiments have quantified the effects of sward characteristics on the DM intake of dairy cows at various stages of lactation (Stockdale 1985, 1997, 1999, 2000; Stockdale *et al.* 2001; Wales *et al*. 1997, 1998, 1999; Dalley *et al.* 1999) and curvilinear relationships have been established between pasture allowance (the weight of pasture, measured to ground level, per unit of animal liveweight at a point in time (Hodgson, 1979)), pregrazing pasture mass and pasture intake. These relationships have been further refined by descriptions of pasture height and nutritive characteristics of dominant pasture species, which at least partly describe seasonal and stage of lactation effects. A Mitscherlich regression to estimate pasture intake based on experimental data from DPI has recently been reported by Heard *et al.* (2004). All of these relationships have been encapsulated in a simple model, Diet Check, developed for Victorian dairy farmers. Other models, for example GrazFeed (Freer *et al.* 1997), also predict pasture intake, but they often require more detailed descriptions of pastures. These models integrate the nutrients supplied by pastures and other feeds with the requirements of cows to predict milk production or to evaluate whether sufficient nutrients are being consumed for target levels of production. They are essentially operational tools that aid in day-to-day decision making with grazing herds.

SUBSTITUTION

Feeding supplements to grazing dairy cows can have a marked effect on herbage intake. While total DM intake usually increases, cows generally substitute the supplement for some of the pasture they would have otherwise eaten (Leaver *et al.* 1968; Stockdale *et al.* 1997; Stockdale 2000), so that pasture intake decreases to some degree. Substitution rates are variable and are influenced by pasture mass and allowance, pasture quality, and amount and type of supplement consumed, and cannot be measured by farmers. Stockdale (2000) published a regression equation estimating substitution based on significant variables derived from grazing experiments in the northern irrigation region of Victoria. While substitution is calculated in different ways in different nutrition models, Diet Check has incorporated the regression relationship reported by Stockdale (2000).

DECISION SUPPORT TOOLS

It is difficult for farmers to integrate all the factors influencing the efficient feeding of dairy cows and to make tactical decisions in relation to pasture allowance or supplementary feeding that are pro-active rather than reactive. Decision support tools can help overcome limitations in applying sound nutritional principles, and can be used to predict future outcomes before resources are committed, and importantly are a valuable educational aid.

A number of decision support tools are available to help farmers make more informed feed management decisions. Tactical nutrition models, such as Diet Check (Heard *et al.* 2004), estimate energy balance based on DM and nutrient intake from pastures and supplements and estimates of substitution under described feeding conditions using the types of regressions described above.

GrazFeed (Freer *et al.* 1997) and CAMDAIRY (Hulme *et al.* 1986) predict milk production and liveweight change at a point in time by allocating a proportion of energy intake to maintenance, milk production, gestation, activity and liveweight change, and, in GrazFeed after estimating pasture intake. In all these programs, animal requirements are based on the Australian Feeding Standards (SCA 1990).

CONCLUSION

This paper provides an overview of some of the tools available to assist farmers to more efficiently feed dairy cows, with the objective of improving on-farm productivity. The low annual productivity gains on dairy farms is a concern to the industry, and while some farmers managed complex systems well, others do not. The benefits of feed budgeting in terms of on-farm productivity and efficiency are large (W.J. Fulkerson *pers. comm*.). While a range of decision support tools are available that can assist farmers in the integration of the complex relationships involved in efficiently feeding grazing dairy cows, they are not widely used and it would be valuable to understand more fully the reasons for this.

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