PROTEIN AND ENERGY REQUIREMENTS OF HORSES

R.A. LENG* and I.D. HUME*

We have recently commenced studies on glucose and nitrogen metabolism in growing horses. This paper reviews the current recommendations on protein and energy requirements of horses, all of the information being of overseas origin. No nutritional research has been conducted on horses in Australia previously, and there is virtually no information on the nutrition of grazing horses.

I. ENERGY REQUIREMENTS

(a) Maintenance

The maintenance energy requirement of the horse recommended by the N.R.C. (1966) was 138.3 kcal digestible energy (DE)/ $W_{kg}^{0.75}$/day. This was based largely on work with cattle, and Ott (1971) recommended that the value should be about 25% higher than this, based "on the author's research, experience and judgement'! The latest recommendation of the N.R.C. (1973) is 155 kcal DE/$W_{kg}^{0.75}$/day, based on zero bodyweight change plus normal activity of the nonworking horse. Nevertheless, there are several estimates below this (e.g. 114 kcal DE/$W_{kg}^{0.75}$/day (Knox, Crownover and Wooden, 1970), 112-128 kcal DE/$W_{kg}^{0.75}$/day (Hoffman, Klippel and Scheimann, 1967) and 147 kcal DE/$W_{kg}^{0.75}$/day (Barth, Williams and Brown, 1977)). The variation is no doubt at least partly a result of differences in measurement conditions, the lower estimates probably coming from animals closer to basal metabolic conditions.

(b) Work

Several recent studies have reported on energy requirements for work, including those of Hintz et al. (1971) and Barth, Williams and Brown (1977). The N.R.C. (1973) requirements are based on the studies of Hintz et al. (1971), and are listed in Table 1. These can only be taken as guides, since many factors, including the type of work, condition and training of the animals, the ability of the rider, and environmental conditions can influence the total energy requirement, and little information on the quantitative significance of each is available.

(c) Growth

Early N.R.C. estimates of the energy requirements for growth of horses were based directly on information from cattle. The N.R.C. (1973) calculations of DE requirements above maintenance for growth of horses have been revised in the light of more recent data on growth and body composition of horses (Hintz and Loy, 1966; Stowe, 1969), and are incorporated into the equation:

$$Y = 3.8 + 12.3\ X - 6.6\ X^2$$

where Y = kcal DE required per g of gain above maintenance and X = fraction of adult bodyweight.

*Department of Biochemistry and Nutrition, University of New England, Armidale, N.S.W. 2351.

TABLE I Energy requirements of horses for work

Activity	Requirement above maintenance (kcal/kg bodyweight/hr)	Increase in DE requirement above maintenance for 800 kg horse (%)
Walking	0.5	-
Light (slow trotting, some cantering)	5.1	47
Medium (fast trotting, cantering, some jumping)	12.5	79
Heavy (cantering, galloping, jumping)	24.0	114
Severe (strenuous effort)	39.0	130

(d) Reproduction

At least 60% of foetal development occurs during the last 90 days of gestation; during the first 8 months the mare's requirements are therefore essentially those for maintenance. During late gestation mares require at least 20-30 kcal DE/$W_{kg}^{0.75}$/day above maintenance (Ott, 1971), an increase of about 25%.

Lactation is probably as demanding in terms of nutrients as very rapid growth. Milk production in mares peaks at 2-3 months,, and during this early part of lactation the foal receives the bulk of its nutrients from the mare. The energy requirements above maintenance for mares under light work are given in Table 2. Individual variation is considerable, however, in the mare's ability to produce milk, and in the mobilization of body energy reserves when energy intake is less than adequate.

TABLE 2 Energy requirements of lactating mares under light work

Milk production (l/day)		Increase in DE requirement above maintenance (%)
5	(low)	100
10	(medium)	140
15	(high)	200
25	(very high)	250-300

A stallion that serves 70-100 times in 4 or 5 months requires about as much energy as when in moderate work, about 25% above maintenance.

II, PROTEIN REQUIREMENTS

(a) Maintenance

The N.R.C. (1973) estimates that the maintenance requirement of horses for digestible crude protein is 3.0 $g/W_{kg}^{0.75}$/day, or 19.4 g/Mcal DE in the diet. This assumes normal muscular activity in a non-working horse, and compares closely with results from early work (Olsson and Ruudvere, 1955) and more recent studies (Slade, Robinson and Casey, 1970). The maintenance requirement of horses is relatively low, amounting to only 6% digestible crude protein (DCP) of average quality. A safety margin is included in the estimates of required DCP levels in the diet shown in Table 3. Knox, Crownover and Telle (1971) suggested that the maintenance requirement may be double the N.R.C. (1973) value, but it appears that the diets used were limiting in DE; the results were also based on only two animals.

TABLE 3 Protein requirements of horses

	Digestible crude protein (% of ration)
In creep rations	18-20
Weanlings	14-16
Yearlings	12-14
Mature horses	8-10
Pregnant mares (last 90 days of gestation)	11-12
Lactating mares	13-15

(b) Work

Significant amounts of nitrogen are lost in sweat from 'horses during exercise. Amino acid catabolism (i.e. muscle protein turnover) is also accelerated during muscular activity. Thus there is a small but significant increase in protein requirements with work. However, if the additional energy required for work is supplied by feeding greater amounts of the maintenance diet, the increased protein requirement will also be covered.

(c) Growth

N.R.C. (1973) estimates of protein requirements for growth are based on very limited information from horses, especially on changes in body composition during growth. This can be seen from the number of assumptions made in the calculations (NRC, 1973). For instance, it is assumed that the fat percentage of the whole body increases linearly from 2.5% at birth to 15% at maturity, and that 45% of DCP above maintenance is deposited in the carcase during growth. It is also assumed that the dietary protein is of reasonable value; for poor quality proteins the dietary requirement for growth will be increased. Recommended protein levels in the diet are shown in Table '3.

(d) Reproduction

As with energy the mare's requirements for DCP during the first 8 months of gestation are essentially those of maintenance. In the last 90 days of gestation the requirement increases from about 9% DCP to

12% DCP, or to 6 g DCP/$W_{kg}^{0.75}$/day. During early lactation this requirement increases to about 10 g DCP/$W_{kg}^{0.75}$/day, or 15% DCP in the diet (Table 3).

III. ABILITY OF PASTURE TO SATISFY PROTEIN AND ENERGY REQUIREMENTS OF HORSES

The ability of pasture and hay to supply the energy and protein required by the horse depends on a number of factors, the most important of which are the pasture species and its stage of growth. Pastures can be conveniently'divided into :

(i) Low fibre pastures (typified by late spring growth in New England, when the crude protein (CP) content may be in excess of 25% of the pasture dry matter, and the neutral detergent fibre content (or total cell wall constituents) may be 35%).

(ii) Medium fibre pastures (at flowering, when the CP content of the dry matter may be 12 to 15%, and the neutral detergent fibre (NDF) content may be 50 to 55%).

(iii) High fibre pasture (when the pasture is senescent, the CP content is 5 to 6%, and the NDF content is perhaps 65 to 70% of the dry matter).

Westonand Hogan (1973) have calculated total feed requirements and likely total feed intakes of mature grazing ewes on these three pasture types during a reproductive cycle. Virtually no work has been done on the nutrition of grazing horses, but some basic assumptions can be made from ruminant research on the possible ability of such pastures to support production in horses. Figure 1 is adapted from Weston and Hogan (1973) in order to illustrate the significance of the nutrient demands for reproduction of the feed requirements of mares throughout the year. It can be seen that with low fibre forage the mare should have no difficulty consuming the amount of feed required except at the peak of lactation, when some small loss of body tissue would be expected. With medium quality pasture sufficient feed would be consumed during maintenance and pregnancy, but tissue stores would be drawn on heavily to sustain a high level of milk production unless a concentrate supplement was provided, With the high fibre pasture the intake achieved would probably only maintain the bodyweight of the non-pregnant mare.

Figure 2 illustrates the effect of light work (Figure 2a) and medium work (Figure 2b) on the total feed requirements of mares through a reproductive cycle. We are not suggesting thatmares be worked in late gestation, and early lactation, but it is not unusual to work them in early-pregnancy and late gestation. With light work there is approximately a 40% increase in total feed requirements, and with medium work there is about an 80% increase. As can be seen, only the low fibre pasture will provide sufficient nutrients for light or medium work in the non-pregnant mare; during gestation and lactation a concentrate supplement would be required. On both the medium and high fibre pastures supplementation would be essential for both maintenance of nonpregnant mares and reproduction.

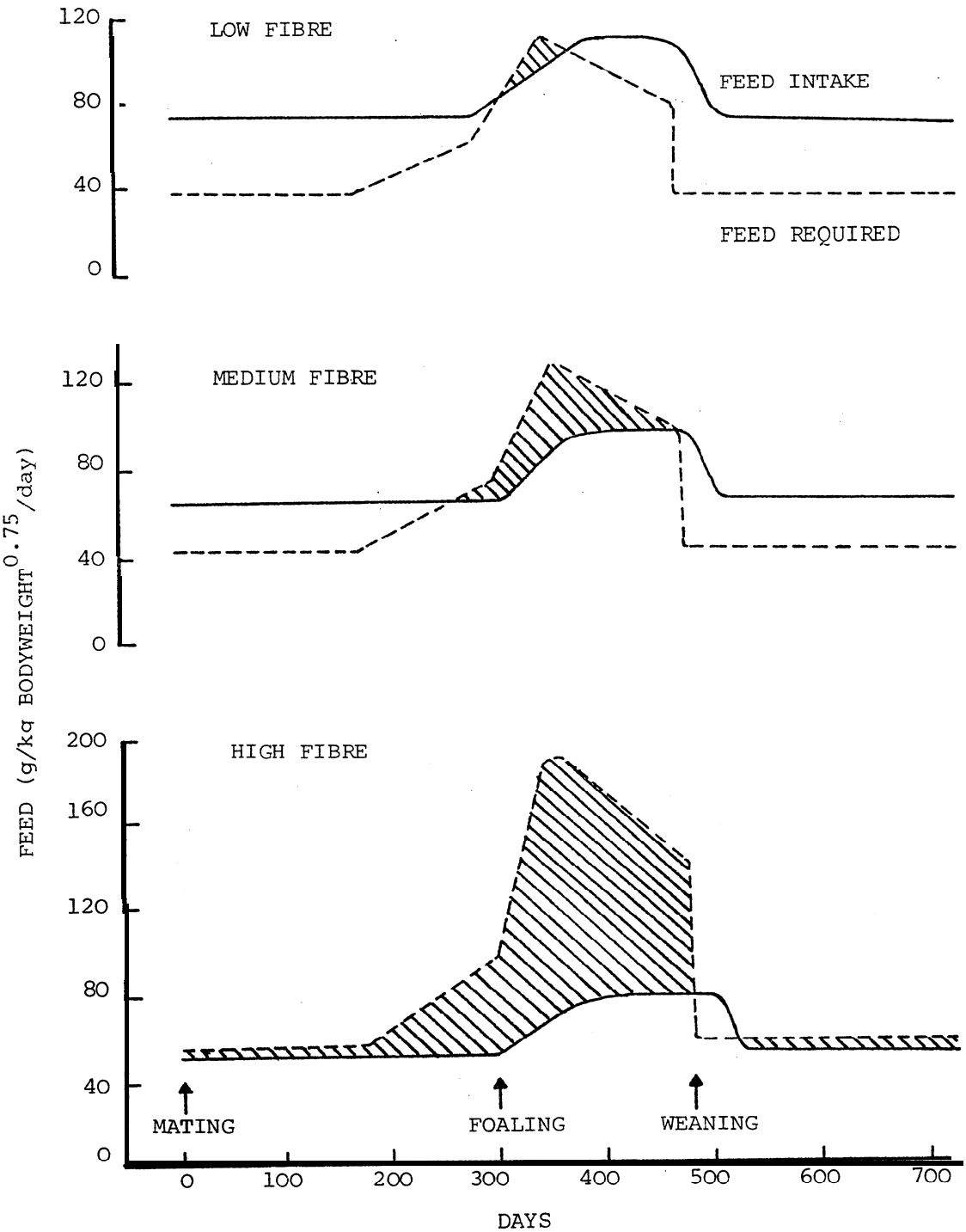

Figure I. The feed requirement and the likely maximum feed intake throughout the reproductive cycle of a nonworking mare- The hatched areas indicate periods of feed inadequacy. Adapted from Weston and Hogan (1973).

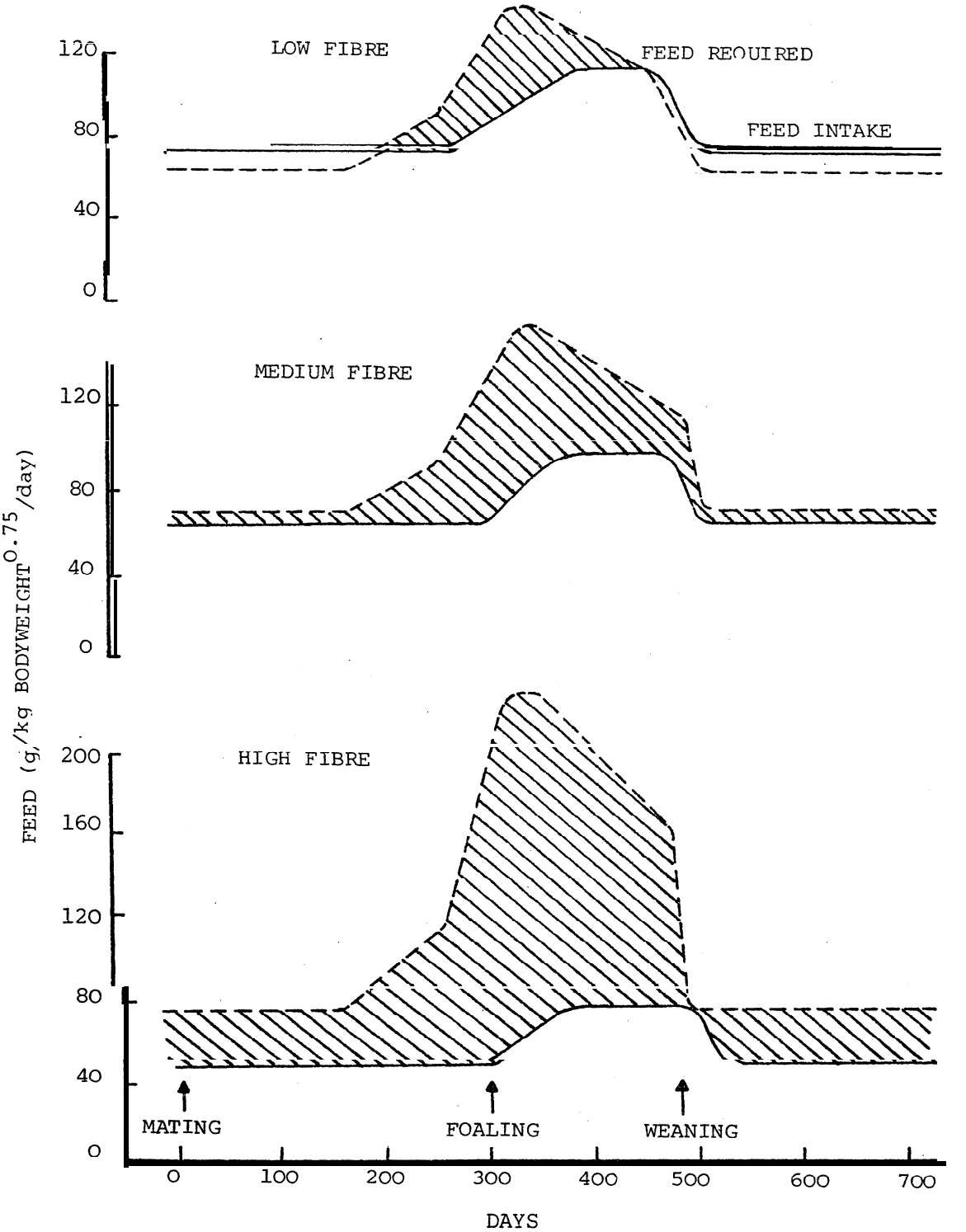

Figure 2a. The feed requirement and the likely maximum feed intake throughout the reproductive cycle of a mare under light work (feed requirements increased by 40% above nonworking mare). The hatched areas indicate periods of feed inadequacy.

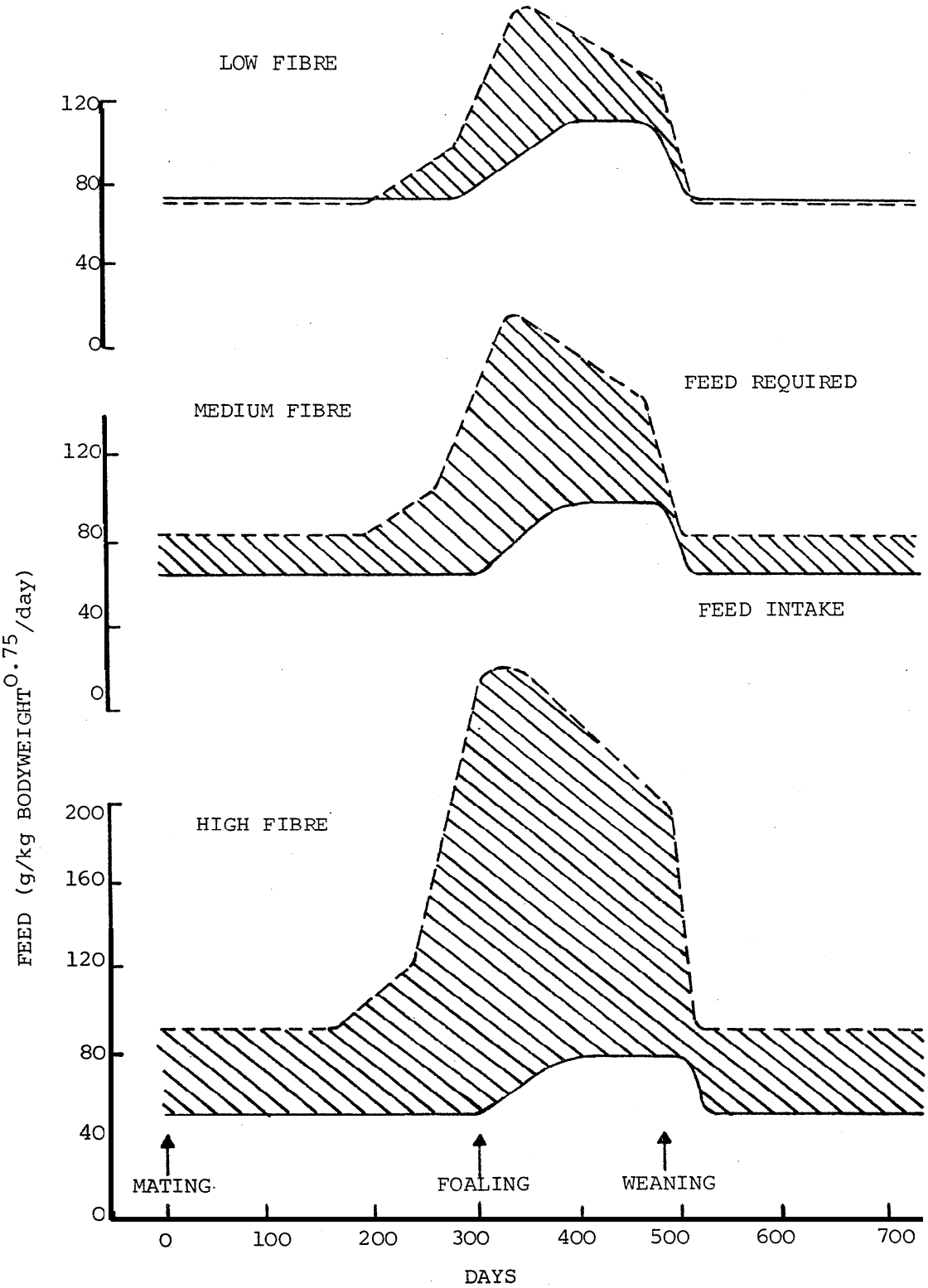

Figure 2b. The feed requirement and the likely maximum feed intake throughout the reproductive cycle of a mare under medium work (feed reauirements increased by 80% above nonworking mare). The hatched areas indicate periods of feed inadequacy.

IV. THE ROLE OF GLUCOSE AND GLUCOSE REQUIREMENTS FOR GROWTH

Like all other mammals, horses require glucose for metabolism in the brain, in red blood cells, and for the developing foetus. In growing lambs Leng and Ball (1978) found that over half the radioactivity from ^{14}C-glucose infused into the blood entered pools with long retention times, suggesting that glucose was also an important nutrient for tissue synthesis. It was also suggested (Leng, Economides and Ball, 1978) that increased glucose availability in sheep could spare amino acids from deamination and thus increase the efficiency of utilization of protein by the animal.

On low fibre pastures nonruminant herbivores such as the horse absorb large amounts of glucose from the small intestine, but on high fibre diets the structural carbohydrates of cell walls will be largely fermented in the large intestine, and the volatile fatty acids (VFA) so produced make a substantial contribution to the DE absorbed by the animal. In this situation the glucose requirements of the horse are met by gluconeogenesis from precursors such as amino acids. This would be expected to reduce the efficiency of protein utilization in growing horses. Thus it is proposed that the balance between protein and sugar or starch in the diet is of great importance in the growina horse, just as the balance between protein and glucose absorbed is important in growing lambs and calves (Kempton, Nolan and Leng, 1977). Any additional energy requirements for work in young horses will alter the optimal balance between protein and sugar or starch in the diet.

At the University of New England we are studying the optimal levels of protein and non-structural carbohydrate in the diet of nonworking ponies growing at different rates on diets varying in cellulose and starch plus sucrose at low and high protein levels in the diet. By using isotopically labelled glucose we are able to follow the fate of infused glucose, and therefore calculate the amounts of glucose required for particular qrowth rates. From this we hope to be able to make recommendations in relation to the requirements of horses for starch in the diet under a number of different feeding regimes.

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