Chapter 2. General Materials and Methods

This research was designed to fit the mission and facilities of the Virginia Tech Middleburg Agricultural Research and Extension Center — the "MARE Center. The mission, that is, the best management of the land for the animal and of the animal for the land, was voiced by Mr. Paul Mellon in 1949, when he donated the land.

Animal management research began with studies of beef and dairy herds, and forage research provided data which are the basis for work there today (Blaser et al., 1986). In 1988, additional funds from Mr. Mellon made possible the conversion of the cattle research center to the MARE Center, with the conversion of fescue pasture to a bluegrass and clover mix, and the construction of new facilities by 1992, including fencing suitable for horses, a stable and office, which houses a modest laboratory, clinic and conference room suitable for extension meetings.

Thoroughbred mares and foals were used in these studies. They were maintained on adjacent bluegrass/clover pastures. Twenty mares and their foals were used in 1994 to 1995, and twenty mares and foals in 1995 to 1996. The mares were paired by age, breeding date and sire of their foal, and then randomly assigned into two groups. In each year, ten mares and their foals were fed a corn grain and molasses supplement (SS) and ten a corn oil and fiber (beet pulp, soy hulls and oat straw) supplement (FF). The ingredient composition of the supplements is shown in Table 2.1. Corn oil was used because work in our laboratory indicated that it was largely preferred over other vegetable fat sources (Holland et al., 1997). Beet pulp, soybean

hulls and oat straw were chosen as fiber sources in order to provide a range of soluble and insoluble fibers (Figure 2.1), and thus establish different fermentative ability and a variety of intestinal microflora.

Prior to the beginning of the study, 20 pasture samples were collected to assess the nutrient profile of available pasture (Table 2.2). Goals for micronutritent supplementation of the pasture were in the range of 1.4 to 2.0 times current minimum requirments (NRC, 1989). A mineral premix (Table 2.3) was mixed by hand throughout the study to ensure consistency of mineral content of the rations. Trace minerals in the premix were added to a white salt carrier to form 4.54 kg of premix. Likewise, goals for vitamin supplementation led to the formation of a vitamin premix (Table 2.4), which was kindly donated by Hoffman-LaRoche (courtesy of Dr. Theodore L. Frye, Nutley, NJ). The mineral and vitamin premixes were then mixed with the soybean meal portion of the ration, in hopes of acertaining equal distribution of the mineral throughout a 2 ton batch. The supplements were formulated to be isocaloric and isonitrogenous, and their mineral contents were balanced with the pastures to meet or exceed NRC (1989) requirements (Table 2.2).

The mares and foals were fed in pans on the ground so that both had access to the supplement. The pans were placed in approximately a 30 m circle, with *(n + 1)* pans available, *n* equalling the number of horses. Feed was distributed using an all-terrain vehicle, so that all pans were filled within 5 min. In this manner, each horse, from the group leader to the most submissive mare, was observed eating its own portion of the total amount offered to each group. Although some mares may have

received more or less than the desired amount, careful observation indicated that the coefficient of variation was on the order of approximately 10% or less, almost certainly less than variation associated with daily pasture intake (Kronfeld, 1997).

The supplements were fed in varying amounts with goals of a 1:2 supplement:forage ratio, to maintain body condition scores between 5 and 6. When necessary in fall and winter months, the pasture was supplemented with mixed grass legume hay, provided in large round bales or small square bales. The forage in the hay varied, from orchardgrass, fescue or bluegrass, and alfalfa, red or white clover, but hay from the same cutting was fed to each group at the same times.

Rebreeding of the mares on the study involved random assignment to one of three stallions. At weaning during the first year of the study (1994), mares that were aged or did not maintain a pregnancy (4 SS and 6 FF mares) were replaced with pregnant mares. Mares that were maintained on the study for 1994 to 1996, remained on their respective diets for both years. The replacement mares were assigned to groups by pairing them with existing mares by age, breeding date and sire.

The foals were weaned between 5 to 7 mo of age and maintained on their respective diets. Anthelmintic, vaccination, and hoof trimming schedules routine to the Virginia Tech MARE Center were followed (Ley et al., 1992). Throughout the study, mares and foals were maintained on pasture with three-sided sheds available for shelter. Stall rest was employed only in rare cases when medical treatment deemed it necessary, and during the first five days after foaling, in order to provide health care for the neonate.

Both supplements were well accepted, with all amounts consumed at each feeding. The amounts of supplement fed in each pan over the experimental period are summarized in Tables 2.5 and 2.6. New batches of the supplements were mixed approximately every two weeks. No problems with spoilage or rancidity were noted.

Table 2.1. Ingredient composition (%) of the sugar and starch (SS) and fat and fiber (FF) supplements.

Ingredient	SS	FF
Corn dent yellow grain	61	4
Soybean meal	17	22
Oat straw	5.5	23
Soybean hulls	3	15
Beet pulp	0	16.5
Molasses (cane)	10	5
Corn oil	0	11
Calcium phos dibasic	1.00	1.70
Limestone	1.50	.8
Mineral premix (Table 2.3)	.5	.5
Vitamin premix (Table 2.4)	.5	.5

Table 2.2. Nutrient profile of the supplements and pasture fed to mares during gestation and lactation. Data for the supplements were calculated from typical values for ingredients (NRC, 1989) and are expressed on an as fed basis. Data for pastures were obtained by proximate analysis (Virginia Tech Forage Testing Laboratory, Blacksburg) and are are expressed on a dry matter basis as a 90% C.I.

Nutrient	SS	FF	Pastures (n = 20)
DE, Mcal/kg	3.00	2.98	1.39 – 4.70
CP, %	14.6	15.3	12.5 – 24.4
ADF, %	7.2	22.8	24.7–35.5
NDF, %	12.6	34.0	not analyzed
Fat, %	2.3	12.2	not analyzed
NSC, %	63	25	not analyzed
Ca, %	.93	.95	.26–.65
P, %	.57	.56	.23–.36
Mg, %	.21	.22	.14–.24
Fe, mg/kg	150	150	89–524
Zn, mg/kg	192	192	17.7–31.4
Cu, mg/kg	60	60	6.1–13.8
Mn, mg/kg	192	192	34.4–98.6
Se, mg/kg	.6	.6	< .08
I, mg/kg	.6	.6	< .08

Table 2.3. Composition of the mineral premix. The premix was developed considering current recommendations (Column 2, NRC, 1989) and goals for total intake (Column 3). Endogenous mineral concentrations in the forage (Column 4) were averaged from proximate analysis (by the Virginia Tech Forage Testing Laboratory) of 20 pasture samples. Endogenous mineral concentrations in the concentrates were calculated for the SS and FF diets from NRC (1989) tables and averaged (Column 5). Assuming a 1:2 concentrate:forage intake, the amount of mineral to be added to the premix (Column 6) to reach goals (Column 3) was calculated. The salt used to provide the mineral is shown in Column 7. Trace minerals in the premix were added to a white salt carrier to form .5% of the supplements. The concentrations of the salts in the premix are shown in Column 8, and the final concentration of the mineral in the ration in Column 9.

1 Mineral	**2** NRC, ppm	**3** Intake Goal, ppm	**4** Endogenous in Forage, ppm	**5** Endogenous in SS & FF, ppm	**6** Mineral needed to be added, g/kg premix	**7** Salt used to provide mineral	**8** Salt, g/kg premix	**9** Mineral, mg/kg ration
Fe	50	50	197	400	10	$FeSO_4*7H_2O$	46	150
Zn	40	64	25	36	21	$ZnSO_4*7H_2O$	94	192
Cu	10	20	10	15	5	$CuSO_4*5H_2O$	20	60
Mn	40	64	66	42	3.6	$MnSO_4*H_2O$	11	192
Se	.1	.2	0	.17	.086	Na_2SeO_3	.19	.6
I	.1	.2	0	.26	.068	KI	.09	.6
Carrier						NaCl	830	

Table 2.4. Composition of the vitamin premix*, added at .5% of the supplements.

Vitamin	Concentration per kg Premix	Concentration per kg Ration
A, IU	1,380,000	6,900
β-carotene	3,520	17.6
D_3, IU	258,000	1,290
E, mg	26,400	132
C, mg	66,500	333
Niacin, mg	3,000	15
Thiamin, mg	1,400	7
Riboflavin, mg	700	3.5
Folic acid, mg	66	.33
Biotin, mg	42	.21

* Courtesy of Dr. Theodore L. Frye (Hoffman-LaRoche, Nutley, NJ)

Table 2.5. Amounts of supplements fed to mares, foals, weanlings and yearlings in 1994 and 1995.

Horses	Dates fed	Amount per pan, kg/d
Pregnant mares	Basal, prior to study	2.7[a]
Mares, late gestation	March 1994	2.7
	late March	3.5
Mares, late gestation – foaling – early lactation	April – June	4.0
Mares with foals	June – November	3.2
Weaned foals	November	1.6
	December	1.8
Yearlings	January 1995	2.0
	February	2.3
	March	2.5
	April – June	2.7
Yearlings, switch SS to FF[b]	June – September	2.7
Weaned mares	November	0[c,d]
Pregnant mares	late November–January	2.7
	February	2.9
	March	3.5

[a]Purina Pure Pride 200, Purina Mills, St. Louis, MO.
[b]Diets were switched and all fed the FF supplement in order to condition for sale.
[c]No supplements were fed for 3 wk to aid in cessation of lactation.
[d]Aged and open mares were culled and replacements added at this time.

Table 2.6. Amounts of supplements fed to mares, foals, weanlings and yearlings in 1995 and 1996.

Horses	Dates fed	Amount per pan, kg/d
Mares, late gestation	March 1995	3.5
Mares, late gestation – foaling – early lactation	April – June	4.0
Mares with foals	June – November	3.2
Weaned foals	November	1.6
	December	1.8
Yearlings	January 1996	2.0
	February[a]	2.3
	March	2.5
	April – June	2.7
	July – September[b]	2.9
Weaned mares	November	0[c,d]
Pregnant mares	late November–January	2.7
	February[a]	2.9
	March	3.5

[a]A blizzard with over 90 cm of snow fell on Feburary 7, 1997, and hindered our ability to feed the supplements. The supplements were not fed until February 11, and then fed in individual piles on top of the snow (pans were buried) until February 20.
[b]Unlike June–September in 1995, there was no diet change at this time.
[c]No supplements were fed for 3 wk to aid in cessation of lactation.
[d]Aged and open mares were culled and replacements added at this time.

Literature Cited

Blaser, R. E., R. C. Hammes Jr., J. P. Fontenot, H. T. Bryant, C. E. Polan, D. D. Wolf, F. S. McClaugherty, R. G. Kline, and J. S. Moore. 1986. Forage-Animal Management Systems. Bulletin 86-7. Virginia Agricultural Experiment Station, Virginia Tech, Blacksburg, VA.

Holland, J. L., D. S. Kronfeld, G. A. Rich, K. A. Kline, J. P. Fontenot, T. N. Meachem, and P. A Harris. 1997. Acceptance of fat and lecithin containing diets by horses. Appl. Anim. Behav. Sci. (In press).

Kronfeld, D. S. 1997. Variations in energy requirements of horses and errors in estimation of pasture intake. Proc. Equine Nutr. Physiol Soc. 15:383.

Ley, W. B., J. M. Bowen, and C. D. Thatcher. 1992. Equine Preventive Medicine. Virginia Maryland Regional College of Veterinary Medicine, Blacksburg, VA.