

Dry Season Forage Selection by Alpaca [*Lama pacos*] in Southern Peru

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Abstract

Two hundred eighty adult female alpacas (*Lama pacos*) and 200 tui alpacas (young alpacas 3–7 months of age) were grazed on a *Festuca-Calamagrostis* association at the South American Camelids Research Station, La Raya, Peru, during the dry season and early wet season of 1981 (June–December). Vegetation was sampled monthly during this period for herbage yield by species. Fecal material from both adult female alpaca and tui alpaca was collected monthly for microhistological analyses of food habits. Alpacas were primarily grazers rather than forb eaters during the dry season and early wet period of 1981. Forage classes consumed were different for adult and tui alpaca. Tui alpaca consumed more grass-like plants and forbs than adults during the driest months. Diet indices revealed the following as highly selected, common forage species: *Eleocharis albibractea*, *Poa* sp., *Calamagrostis heterophylla*, *C. vicunarium*, *Alchemilla pinnata*, *Muhlenbergia fastigiata*, and *Carex* spp. Highly selected, trace species were *P. gymnantha*, *M. peruviana*, *Stipa brachiphylla*, *Ranunculus limoselloides*, and *Trifolium amabile*. *Festuca dolichophylla* had been considered by range managers as highly preferred species overall. However, because it was the most abundant species (73% of the total forage yield), *F. dolichophylla* had a low selection index during the dry season. Alpacas consumed remarkable quantities of grass seeds (up to 20% of the diet) during the driest months of the year, apparently compensating for low quality forage.

The Andes of Peru comprise about 22 million ha of rangeland and support more than 50% of the domestic livestock in Peru (San Juan de Chuquibambilla 1981). The "Altiplano" or highland plateau accounts for 7 million ha. Large-scale cultivation in the Altiplano is not feasible and economy primarily is dependent upon herding by local pastoralists.

There are 4 species of New World Camelids: the alpaca (*Lama pacos*), the llama (*L. glama*), the vicuña (*Vicugna vicugna*), and the guanaco (*L. guanicoe*) (Reiner and Bryant 1983). The 2 former species are domesticated and the latter 2 are wild. The entire population of these mammals is distributed in the Andes of Peru, Bolivia, Chile, and Argentina. Most alpacas and llamas are in Peru and Bolivia, a few are in Chile, but practically none occur in Argentina.

The alpaca is a dual purpose animal because it produces high quality fiber that is exported, and meat that is needed by a growing population. Because of current husbandry practices, rangelands are severely overgrazed (Holgado et al. 1979). Also, poor grazing practices are confounded with the seasonal distribution of precipitation. About 80% of the rainfall comes during the wet season

(December–April). Rangeland production follows this pattern with an abundance of forage in the wet season and scarcity in the dry season.

Because of the long gestation period for alpaca of approximately 11 months, the 2 major periods of nutritional stress (late gestation and early lactation) coincide with the rainy season. However, during the dry season, alpaca females must support maintenance and early gestation on poor quality forage that may also be low in quantity. Consequently, this depressed period of nutrient supply is of major concern to range managers.

West (1981) noted that improvement in alpaca production depends on: (1) adequate nutrition, (2) disease control, (3) proper herd management, and (4) genetics. Since adequate nutrition is influenced by plant species selected, an accurate evaluation of a grazing animals' diet facilitates application of range management principles (Scott and Dahl 1980). The objectives of this study were (1) to determine the botanical composition of diets of alpacas during the dry and early wet season, (2) to determine the forage available to adult and tui alpacas, and (3) to evaluate diet selection of adult and tui alpacas.

Study Area and Methods

Study Area

The National Center for South American Camelids Research Station at La Raya is located at the Andes Mountains of Southern Peru, Department of Cusco, near coordinate 14° 30' southern latitude and 71° western longitude. The altitude ranges from 4,000 – 5,500 meters, with the lowest altitude at Aguas Calientes and the highest altitude on Chimboya (Holgado et al. 1979).

The high Andes have low atmospheric pressure, low oxygen availability, and intense solar radiation. Additionally, the highlands of Peru have a diurnal temperature regime rather than a seasonal one (Thomas and Winterhalder 1976). The diurnal variation in temperature sometimes exceeds 30°C. During the dry season, the shorter day length and lack of cloud cover permits heat loss from radiation. Nightly frosts are more frequent and more severe. In most places in the Sierra, frost can occur any time of the year and the risk increases with altitude (Orlove 1977). Meteorological data (1972–78) from the La Raya Research Station showed a mean annual temperature of 6.5°C and 952 mm of precipitation (Holgado et al. 1979).

Data for soils are sketchy. Wilcox and Bryant (1982) characterized 3 major soil sites in the Andes of Central Peru. Bottomland sites (<8% slope) generally were classified as organic soils. Soils of upland sites (8–30% slope) were organic soils and mollic cryoborolls. Steep slope sites (>30% slope) were mollic cryoborolls and developed from glacial till or residual rock.

According to Holdridge (1967), La Raya is classified as very wet subalpine life zone. Orlove (1977) pointed out that the dominant vegetation forms are bunchgrasses including *Stipa*, *Festuca*, and *Calamagrostis*. Each genera contains a number of species but grass morphology is similar, i.e., dense, deeply rooted clumps 5 to 20 cm in diameter and 15 to 60 cm in height, and composed of many leaves from short vegetative shoots. Small (<10 cm) interstitial grasses and forbs find the microclimate adjacent to the bunchgrass favorable.

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Methods

Herbage yield was estimated from 3 parallel transects placed through the 200-ha study area. Thirteen, 0.25-m² quadrats were placed randomly along each transect. Herbage from each quadrat was clipped monthly, by species, air dried, and weighed. Quadrats were relocated each month.

Microhistological analyses of fecal material was used to identify plant fragments for botanical composition of diets. Reference plants were collected during February, 1981. Since alpaca use common voiding areas to defecate, 30 fresh fecal samples of adults and tuis (young alpaca 3–7 mos of age) were collected monthly from dung piles. Fecal pellets were separated by size class (adult pellets were 20 times the mass of tui pellets) and each class was thoroughly hand-mixed. Samples were preserved in a 10% formalin solution as recommended by Medin (1970). After a 2-day treatment with formalin, samples were dried, weighed, stored in plastic bags, and transported to the Texas Tech University Food Habits Laboratory for subsequent analyses.

Herbage yield was measured and fecal collections were made during a 7-mo period from June through December. Fecal material from tuis was collected for 4 mos from June to weaning (September). Two reference slides were made from the reference plant collection for each plant species and for individual plant parts such as stems, leaves, flowers, and seeds. Plants and plant parts were placed in a blender and agitated for 1 minute. Frequently, it was necessary to soak plant parts in a weak clorox solution for 1 to 2 days in order to remove chlorophyll for clarification of plant parts.

Five slides were prepared for each fecal sample. The microhistological identification process for monocot and dicot species was based on comparisons of epidermal material in samples with the epidermal patterns on reference slides (Scott and Dahl 1980). If the assumption is correct that the epidermal and cuticle of all consumed plant parts resist digestion, then it would be possible to determine the proportion of still recognizable species in the total sample (Hegg 1961).

The slides were analyzed in 2 ways. First, slides were read to determine flowering parts and seeds from leaf/stem material regardless of the species present. Second, slides were examined for species composition regardless of plant part. Each time, 20 fields per slide were read. Data were recorded as frequency of occurrence on each item in the 20 fields, then converted to percent relative density (Krueger 1972). Percent density has been shown to be a better estimate of percent dry weight in a sample than percent frequency (Sparks and Malechek 1968).

Ratio of the percentage of a plant species in the diet to the

percentage in the herbage yield was used to estimate the relative selection of available range plants by alpaca (Krueger 1972). After selection indices were calculated, plant species were ranked in order of importance.

Results and Discussion

Herbage Yield

A higher proportion of grasses and grass-like plants than forbs occurred in the standing crop biomass (Fig. 1). This proportion

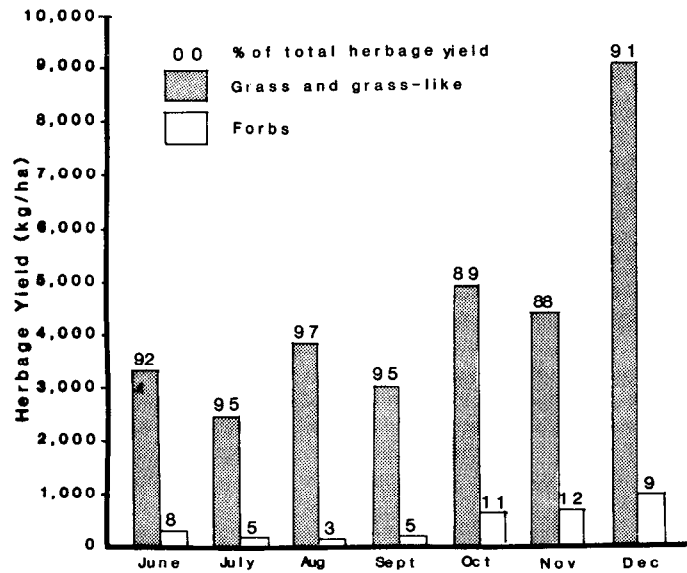


Fig. 1. Monthly availability of grasses, grass-like plants, and forb species on the study site in Southern Peru.

was maintained during much of the study period (June–December). Forb contribution to the overall standing crop was low, representing a minimum of only 3% and a maximum of 12% (Fig. 1).

Festuca dolichophylla accounted for 73% of the total herbage during the sampling period (Farfan 1982). A group of 12 grasses, grass-like plants and forb species made up 24% of the total herbage. These included *Carex*, *Eleocharis albibracteata*, *Festuca rigida*, *Juncus brunneus*, *Muhlenbergia fastigiata*, *Poa* spp., and *Stipa obtusa* among the grass and grass-like forages, and *Alchemilla pinnata*, *Hipochaeris taraxacoides*, *Werneria pygmaea*,

Table 1. Mean percentages of grasses, grass-like plants, forbs and plant parts in diets of adult female and tui alpaca in Southern Peru.

Livestock class	Months							
	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
Adult female								
Forage class								
Grasses	60	70	76	72	60	48	44	61
Grass-like plants	22	18	14	22	30	29	30	24
Forbs	18	12	10	6	10	23	26	15
Plant part								
Leaves/stems	95	97	94	79	87	89	99	91
Seeds	5	3	6	21	13	11	1	9
Tuis								
Forage Class								
Grasses	53	64	69	66				63
Grass-like plants	26	20	20	22				22
Forbs	21	16	11	12				15
Plant part								
Leaves/stems	93	87	83	77				85
Seeds	7	13	17	23				15

Plantago officinalis, and *P. tubulosa* among the forbs. Sixteen species comprised the remaining 3% of the herbage yield.

Botanical Composition of Diets

Adult Alpacas

Grasses and grass-like forages averaged 89% of adult female alpaca diets during the driest months of the year (June–September) and 85% when averaged over the dry season and early wet season (Table 1). Grass consumption was highest during the driest months and declined during the early wet season. Grass-like plants and forbs replaced grasses in the diet as the rainy season began.

Six major grasses and grass-like species averaged 60% in diets through the 7-mo grazing period (Farfan 1982). Individually, *Festuca dolichophylla* averaged 15.5%, *Poa* sp.—12.6%, *Carex* sp.—8.8%, *Muhlenbergia fastigiata*—8.3%, *Stipa brachipphylla*—7.5%, and *Calamagrostis heterophylla*—5.9% of the dry season diets.

Since there are no data on alpaca forage selection, it is interesting to compare their diets with results from other small ruminants. Studies have shown the grasses in the diets of Angora and Spanish goats rarely made up more than 55% on ranges where browse was available (Malechek and Leinweber 1972, Bryant et al. 1979). Sheep diets seem to be more similar to those of alpacas because they consumed larger quantities of grass than goats on shrub range (Cook et al. 1967, Kothmann 1968, Bryant et al. 1979), but the percentages are not as high as those found for alpacas in our study. Where grasses dominate herbage yield, sheep diets approach the levels of grass (Wilson 1976) found in alpaca diets. These results suggest alpacas and sheep may compete for limited dry season forage if they select the same species.

Forbs averaged 15% of the adult female diets (June–December) (Table 1). There was high consumption of forbs by alpacas during the initial months of the dry-season trial, a time when forb availability was lowest. Selection of forbs also has been demonstrated for other small ruminants (Malechek and Leinweber 1972, Bryant et al. 1979, Wilson 1976).

Adult alpaca depend mostly on grasses and grass-like forages during the driest months of the year. Lack of a browse component in the high Andes forces alpaca to consume primarily grass and grass-like plants when forb availability declines. The increase in forb consumption in November and December (early wet season) suggests adult alpaca eat more forbs when climatic conditions favor plant growth. Increased forb consumption by alpacas during the growing season as compared with the dormant season also has been demonstrated for sheep (Kothmann 1968, Bryant et al. 1979), cattle (Van Dyne and Heady 1965), goats (Malechek and Leinweber 1972), and deer (Chamrad and Box 1968).

Seed consumption in adult female alpaca diets averaged 9% for the grazing period. Seed consumption was lowest in June (5%) and reached its highest level in September (21%) (Table 1). Thus, adult alpacas substituted seeds for stem material as the dry season advanced, holding leaf consumption relatively constant. These data suggest that alpacas compensate for lack of quality forage in dry months by eating large quantities of seeds which are rich in proteins, fats, and carbohydrates. This high consumption of seeds has not been reported for other small ruminants on grass-dominated rangeland. (Van Dyne and Heady 1965, Kothmann 1968, Malechek and Leinweber 1972, Bryant et al. 1979).

Tui Alpacas

Grass and grass-like herbage consumption averaged 85% of the tui diets (Table 1) during the driest months, similar to those of adults. But the pattern of grass and grass-like forage consumption was different from that of adult female alpacas, as they had higher dietary levels of grass-like plants than adults. Six major grass and grass-like species averaged 64% in diets through the 4-month grazing period (Farfan 1982). Contribution of individual species to tui diets was *Festuca dolichophylla* (15%), *Poa* sp. (12.3%), *Eleocharis albibracteata* (12.2%), *Muhlenbergia fastigiata* (9.2%), *Stipa*

brachipphylla (8.5%), and *Calamagrostis heterophylla* (6.6%). Whereas, *Carex* spp. was the third dominant species in adult diets, *Eleocharis albibracteata* replaced *Carex* sp. as the third most important species in the tui diets.

Forb consumption by tuis decreased considerably from 21% in June to 12% in September, but dry season (June to September) forb use was still higher in tuis than in adults. Forbs averaged 15% in tui diets during the 4-mo period (June–September) as compared to 12% in adult diets. Two major forb species, *Alchemilla pinnata* and *Trifolium amabile*, averaged 14% of the total tui diet and 82% of the forbs consumed through the 4-mo dry-season grazing period (Farfan 1982).

The pattern of consumption of leaves/stems and seeds by tui alpacas was similar to adults (Table 1). However, tuis ate even more seeds than adults during the driest months of the year, especially during July and August.

Selection for Forage Species

Adult Alpacas

Among the species highly selected by adult alpacas during the dry season and the transition period from dry to wet season were *Eleocharis albibracteata*, *Poa* spp., *Calamagrostis heterophylla*, *C. vicunarum*, *Alchemilla pinnata*, *Muhlenbergia fastigiata*, and *Carex* spp. (Table 2). There was also a group of highly preferred, trace species for which it was not possible to determine their preference index because they comprised very little of the available forage (<0.1%), or they did not appear at all in the field sampling. Consequently, ratings were very high for species like *Stipa brachipphylla*, *Trifolium amabile*, *Bromus lanatus*, and *M. peruviana* (Table 2).

A group of moderately selected species was not available during the dry season but was present during the wet season (October to December). They were primarily grass-like plants and forbs including *Juncus brunneus*, *Luzula peruviana*, *Werneria pygmaea*, *Hipochaeris taraxacoides*, *Plantago tubulosa*, *Miriophyllum* sp. (Farfan 1982).

A group of species relatively low on the selection order included *Lepiquenia* sp., *Plantago officinalis*, *F. orithophylla*, *Stipa ichu*, *S. obtusa*, and *F. dolichophylla*.

Tui Alpacas

Basically, selection indices for tuis resembled those of adult alpacas (Farfan 1982). However, the order of selection was different (Table 2). Among the highly selected species during the dry season were *Poa* sp., *Alchemilla pinnata*, *Calamagrostis vicunarum*, *C. heterophylla*, *Muhlenbergia fastigiata*, and *Carex* sp. (Table 2).

A second group of highly selected species which appeared in the tui diet but were not detected during botanical sampling included *Stipa brachipphylla*, *Muhlenbergia peruviana*, *Trifolium amabile*, and *Bromus lanatus* (Table 2). Species with a relatively low selection index included *Festuca dolichophylla*, *F. rigida*, *S. ichu*, *S. obtusa*, and *Plantago tubulosa*.

Antezana (1972) classified forage species in Southern Peru in terms of palatables (84 species), low palatables (33 species), and relatively unpalatables (30 species). When results of Antezana's (1972) observational method are compared with those of the microhistological technique used in the present study to determine alpaca diet selection, *Alchemilla pinnata*, *C. vicunarum*, *M. fastigiata*, *Muhlenbergia peruviana*, *Poa* sp., and *Trifolium amabile* were the only forage species used by alpacas that Antezana classified as palatables. *Calamagrostis heterophylla*, *Carex* spp., and *Poa gymnantha*, considered highly preferred forage species in this study, were considered species of low palatability by Antezana (1972). *Festuca dolichophylla* was a forage species of low palatability in both studies.

When ranked in order of importance, the top 7 species selected by adults were the top 7 species selected by tuis (Table 2). The order of moderately selected species was different for adults and tuis.

Table 2. Average rank of preferred species based on selection indices for adult female and tui alpaca in Southern Peru during the driest months (June–September).

Plant species	Adults	Tuis
Common species¹		
<i>Eleocharis albibracteata</i>	1	5
<i>Poa</i> sp.	2	1
<i>Calamagrostis heterophylla</i>	3	4
<i>Calamagrostis vicunarium</i>	4	3
<i>Alchemilla pinnata</i>	5	2
<i>Muhlenbergia fastigiata</i>	6	6
<i>Carex</i> sp.	7	7
<i>Juncus brunneus</i>	8	11
<i>Werneria pygmaea</i>	9	8
<i>Festuca rigida</i>	11	14
<i>Hypochoeris taraxacoides</i>	12	9
<i>Luzula peruviana</i>	13	10
<i>Festuca dolichophylla</i>	14	12
<i>Plantago tubulosa</i>	15	15
<i>Stipa obtusa</i>	16	16
<i>Festuca orthophylla</i>	17	—
<i>Plantago officinalis</i>	18	—
<i>Lepiquenia</i> sp.	19	—
Trace species²		
<i>Stipa brachiphylla</i>	1	1
<i>Trifolium amabile</i>	2	3
<i>Bromus lanatus</i>	3	4
<i>Muhlenbergia peruviana</i>	4	2
<i>Miriophyllum</i> sp.	5	5
<i>Ranunculus peruvianus</i>	6	6

¹Species comprising at least 1.0% of the available forage.

²These species were extremely minor components in the available forage (less than 0.1%) or they did not appear at all in the field sampling.

Summary and Conclusions

During the driest months of the year at the La Raya Research Station, adult and tui alpacas depended almost exclusively on grass and grass-like forage species for their diets, but tuis consumed more grass-like plants than did adults. The potential competition between sheep and alpaca sharing a common range should be noted.

The strongest relationship between diet selection and the dynamic variability of available forage was consumption of forbs. But again, forbs were more important to tuis than adults. Higher nutritional requirements of tuis may explain why they consumed more forbs and grass-like plants.

Twelve grass, grass-like and forb species were highly selected by adult and tui alpacas. Among the most important were *Eleocharis albibracteata*, *Poa* sp., *Calamagrostis heterophylla*, *Alchemilla pinnata*, *Carex* sp., *Stipa brachiphylla*, and *Trifolium amabile*. One grass species, *Festuca dolichophylla*, believed to be a species highly preferred species by alpaca in Southern Peru, averaged 73% by weight of the total herbage available but only 15% in the diet. Thus, the selection index showed it to be a relatively unpreferred species, but its importance as a dietary component cannot be overlooked.

Alpacas and tui alpacas consumed large quantities of seeds during the driest months of the year. Compared with other small ruminants, seed consumption by alpaca was remarkable. This high seed consumption could help explain, in part, how both female and growing alpacas cope energetically during the driest months when high quality forage is in short supply.

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