

The Puna—High Elevation Grassland of the Andes

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IT WAS MY FIRST MORNING IN THE ANDES. The air was cold and crisp and the sky was clear blue. The grassland stretched uninterrupted to the horizon. Never had I seen a harder frost. Looking back it must have been a beautiful morning, but at the time I was not fully appreciative of nature's splendor.

I felt alone, the only gringo in an Andean village. My head was aching and my stomach was churning from a common affliction of new arrivals to the high elevation, altitude sickness. Questions were going through my head. Why had I left Lubbock, where I was quite comfortable? Would I ever get used to the altitude? Can a person really subsist on potatoes,

rice, and a little mutton? And was there no escape from the cold? (Indoor heating was a luxury.) Could I live up here for a whole year?

Happily, I did last a year in the "puna," the Peruvian term for the high elevation grassland, and I learned to love the land and the warm, generous people who made my stay so memorable. And yes, even the food began to taste better.

I WAS IN PERU TO INVENTORY THE VEGETATION and soils in one area of the Central Andes. As little of this type of



Corpacancha, the village where the author lived while conducting research, is typical of villages in the high elevation Andes.



The puna is a productive grassland under proper management.

information was previously available, this was a necessary first step for further range research in the puna, primarily grazing studies, by Texas Tech University cooperating with Peruvian institutions. Most of our work was in the area surrounding Corpacancha, a village about 42 km ENE of La Oroya, Peru. The objective of this paper is to acquaint the readers with this unique and important rangeland.

The puna is a high elevation (13,530-16,500 ft) mountainous grassland in the central Andes of Peru. The climate is harsh and unrelenting. Although vegetatively it appears quite similar to some temperate grasslands, such as the intermountain bunchgrass in the northern Rocky Mountain states, climatic conditions are quite different. All of the precipitation is concentrated in a single season, lasting from November to April. Generally the rains are greatest in January and February. Precipitation varies from 20 inches to 35 inches, but droughts are quite common. Snow makes up a

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Communal lands in the puna are commonly overgrazed. Midgrasses have been replaced by decumbent grasses and forbs.

small percentage of the total precipitation below the permanent snowline (17,000 ft) and melts shortly after it falls.

The Andean highlands experience a diurnal temperature regime rather than a seasonal one. There are relatively small changes in average daily temperatures, but large differences in daily highs and lows. Daily temperatures can vary as much as 60° F. Average seasonal temperatures range from 44° F in summer to about 37° F in winter. There is less diurnal variation in the summer wet season because of the insulating effect of the cloud cover. Perhaps most ecologically significant is the frequent occurrence of frosts. Freezing temperatures can occur any night of the year. Rarely do temperatures drop below freezing in the day. At 13,200 ft. frost occurs more than 300 days a year; and at about 15,500 ft, frosts occur nightly. These frequent frosts effectively eliminate a prolonged growing season.

THE DOMINANT CHARACTERISTICS of high Andean soils are their dark upper horizons and acidic nature. Many soils are so "peaty," or high in organic matter, that they serve as the principal source of cooking and heating fuel for the mountain people. The cut and dried sod is known as "champa." Ironically, in spite of the high amounts of organic matter in the soil, most soils are low in available nitrogen. This is because the cold temperatures inhibit decomposition. Available phosphorus also is low. Most of the soils we observed in the puna are quite deep (>30 in.) and moderately well developed.

THE VEGETATION OF THE PUNA HAS EVOLVED for thousands of years under the influence of man and his domestic animals. Today the puna is an open grassland, with abundant low-growing forbs. Trees and shrubs are rare. It has been reported that groves of small evergreen trees or shrubs in the *Polylepis* genus commonly dotted the puna, but because of the demand for cooking and heating fuel, only relict groves remain.

Much of the puna is very heavily grazed, but it is resilient. In overgrazed areas low successional grass and forb species, even though closely cropped, grow very dense. Thus, the valuable soil resource is protected, and potential for range improvement remains high.

Besides frequent frosts and overgrazing, plants in the puna endure a prolonged dry season, frequent droughts, low humidity, high solar radiation, and great fluctuations in daily temperatures. The puna plants have adapted to these conditions in various ways. Most grasses have rolled leaves to reduce transpiration. Forbs typically have felty or light pubescent leaves which aid in water efficiency and protect the plant from the intense solar radiation. Many plants also have thick cuticle layers. Water-storing succulents such as *Opuntia floccosa* are common. Cushion plants such as *Pycnophyllum molle* form a tightly packed mound composed of thousands of reduced leaves. These plants absorb water like a sponge. Root systems typically are well developed. Often the below-ground biomass is many times greater than the above-ground biomass. The high root/shoot ratio of the



The alpaca, world renowned for its wool, is keenly adapted to harsh conditions of the puna.

puna vegetation probably aids in water relations and mineral nutrition. Also, roots store sufficient carbohydrates to allow plants to survive the prolonged dry season.

In the Corpacancha area and in the puna in general, cool-season grasses dominate the vegetation. Common genera were *Festuca*, *Poa*, *Stipa*, *Calamagrostis*, *Muhlenbergia*, *Bromus*, and *Agrostis*. Forbs become much more abundant as slopes become greater than 30% and above elevations of 15,000 ft. Under proper management the puna is extremely productive, although nutritional problems do exist. Our investigations revealed that green biomass alone approaches 1,700 lb/acre during the rainy season on moderately grazed pastures.

Basically two systems of range management exist in the puna. One is communal, where lands are controlled by a community and every member grazes livestock (typically sheep and llamas). These lands commonly are overgrazed. The other system is the cooperative. In the late 60's and early 70's an agrarian reform was initiated, and expropriated land



The versatile llama is produced for its meat and wool, but is also valued as a pack animal capable of supporting 80-lb. cargos.

from the large land holders was turned over to the workers. Ultimately the cooperatives are controlled by a council composed of workers, but on a day-to-day basis they are run by agronomists and animal scientists. Rangeland on these cooperatives usually is better managed than communal lands. The cooperatives produce mostly sheep; however, cattle and alpaca are also raised.

The puna has been inhabited by man for many centuries. Many native inhabitants still earn their livelihood in much the same fashion as their ancestors did. These mountain grasslands are the backbone of Peru, as a large segment of her population depends on the puna. No longer can these grasslands, as they are currently managed, support all who are born there. Overgrazing is epidemic, especially on the communal lands. The range management profession in Peru is in its infant stages and is faced with paramount challenges. The situation however is far from hopeless. Peruvian range scientists recently have initiated range management programs in the universities and are conducting much-needed research. The puna is becoming recognized as a valuable natural resource which must be properly managed. With sound management, the puna can be a tremendously productive rangeland capable of supporting more of Peru's growing population. Management practices, however, must be such that they are compatible with the social structure, and can be implemented with low levels of technology. Development of such practices will require imagination and cooperation with other disciplines, such as rural sociology and anthropology.