ALPACA

AUSTRALIAN ALPACA ASSOCIATION INC.

1990 INDUSTRY SEMINAR PROCEEDINGS

Glenormiston Agricultural College
Glenormiston, Victoria

AUSTRALIAN ALPACA ASSOCIATION INC.

INDEX

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Introduction...

ON BEHALF OF AUSTRALIAN ALPACA ASSOCIATION INC., I WOULD LIKE TO WELCOME YOU ALL TO THE FIRST ALPACA SEMINAR TO BE HELD IN AUSTRALIA. I WOULD ALSO EXTEND A VERY WARM WELCOME TO ALL OUR OVERSEAS SPEAKERS AND VISITORS, AND I HOPE YOUR STAY IS A VERY ME MEMORIAL ONE.

PUTTING A SUCCESSFUL CONFERENCE TOGETHER TAKES A LOT OF WORK, AND I WANT TO EXPRESS MY APPRECIATION TO SOME OF OUR MEMBERS WHO CONTRIBUTED SO MUCH TIME AND TALENT TO MAKE THIS FIRST CONFERENCE COME TOGETHER.

MY ONLY REGRET IS THAT CHARLES LEDGER COULDN'T BE WITH US TODAY. I CONSIDER CHARLES TO BE AUSTRALIA'S MR. ALPACA. HERE'S A MAN SO CONVINCED OF THE ALPACA'S POTENTIAL THAT HE FOUGHT AN INCREDIBLE UPHILL BATTLE TO BRING HIS ALPACAS TO AUSTRALIA. ON NOV EMBER 28, CHARLES LEDGER'S ALPACAS AND LLAMAS ARRIVED IN THE SYDNEY HARBOUR . . . 132 YEARS AGO. HIS BROTHER WRITES, AND I QUOTE, "I AM GLAD TO SAY THE ANIMALS ARE THRIVING WONDERFULLY. OF THEIR SUCCESS I HAVE NO DOUBT . . . I AM PERFECTLY CONVINCED THAT THE ALPACA WILL IN DUE TIME PRODUCE IMMENSE RESULTS TO THIS COLONY . . ."

THE LAST ALPACA, OR PERHAPS IT WAS A LLAMA, PASSED AWAY IN THE SYDNEY ZOO NEARLY 100 YEARS AFTER THE LEDGER BROTHERS FIRST INTRODUCED THEM TO OUR SOIL. THE REASON THEY BECAME EXTINCT IS NOT ENTIRELY KNOWN.

IT IS THE OBJECTIVE OF THE AAA THROUGH OPEN FORUMS LIKE THIS TO SHARE OUR KNOWLEDGE AND IDEAS. IT IS THIS COOPERATIVE EFFORT THAT WILL CAUSE AUSTRALIA'S ALPACAS TO THRIVE.

WE HAVE COME A LONG WAY FROM THOSE FIRST 3 ALASKAN ANIMALS IN 1988 TO WHAT COULD BE OUR LAST MAJOR IMPORTATION. IF WE IN AUSTRALIA DO NOT CAPITALIZE ON OUR GOOD FORTUNE TO HAVE RECEIVED THIS QUALITY GROUP OF ALPACAS, WE CAN ANTICIPATE THAT OTHERS IN THE WORLD WILL DO SO.

IT IS YOU, THIS NEW GENERATION OF ALPACA OWNERS HERE TODAY, THAT WILL PROVE MR. LEDGER WAS CORRECT. ALPACAS WILL SUCCEED IN AUSTRALIA.

SHIPS OF THE ANDES

by ERIC HOFFMAN

One cold night in the Andean highlands, Felix Palacios and Nolberto Chambilla Mandamiento lay in their bedrolls looking at the stars. Around them knelt Llamas, their legs folded snugly under woolly bodies. The animals' thick coats glistened with the frost that occurs 300 nights a year on the puna, the high plain. Felix, a graduate student in anthropology at the Catholic University of Peru in Lima, asked Nolberto, an Aymara-speaking Llama herder, 'If all the Llamas and alpacas died, what would happen?" "We would die," Nolberto replied. "Why?" "Because we raise Llamas and Llamas raise us."

Since 1975 Felix Palacios has worked to record the beliefs of highland herders like Nolberto. Nolberto lives close to Lake Titicaca, which straddles Peru and Bolivia. He represents traditional Andean pastoralism. His livelihood depends on the exchange of native animal products from the inhospitable 14,000-foot (4,200-meter) puna for agricultural goods grown at lower elevations. It is an ancient way of life, based on the only pre-European livestock domestication in the New World, and it echoes back to the rise and fall of once-great civilizations. There is a kinship bond between highland herders and their Llamas and alpacas that is cemented by tradition, devotion, and harsh pragmatism.

Like their Inca forefathers, today's highland pastoralists collect their Llamas, load them with dried Llama meat called charqui (a Quechua word from which we get our English jerky), sacks of dried potatoes, and raw alpaca wool. The pastoralists and their animals trudge for days to villages in the more temperate lower elevations where they trade their goods for maize, wheat flour, squash, quinoa (grain similar to rice), chili peppers, beans, and sometimes fruit. With agriculture marginal at best on the harsh puna, these bartering trips are necessary.

Movement of goods between highland herders, farmers of the temperate Andean valleys, and fishermen on the coast was crucial to the development of Andean cultures, which culminated in the Inca Empire (1438-1532). Spanish conquistador Francisco Pizarro and 170 men put an end to the Inca Empire 457 years ago. Despite constant pressures since the Conquest, Andean pastoralism has survived because both people and animals are well adapted to the harsh Andean environment. Though the animals figure prominently in Andean herders' culture and heritage, the pastoralists' way of life may not survive the pull of modernity.

Of all the animals found in the Americas prior to European colonization, Llamas and their diminutive woolly cousins, alpacas, have had the most comprehensive influence. Like the buffalo in North America, Llamas were a source of meat, fuel (in the form of dried manure), and hides for clothing. But unlike buffaloes, Llamas could be domesticated. They were let out each morning to graze, and they returned to their rock corrals, known as canchones, each evening. These ancient corrals are spread throughout the altiplano (the high plateau around Lake Titicaca and northwestern Bolivia), where they have been used by Llama caravans for centuries.

Llamas are beasts of burden, alpacas are shorn for their high-quality fiber. Both animals are butchered. This level of domestication guarantees a steady source of meat, high-quality textile fiber, and a means to move large amounts of goods through rugged mountain areas. Llamas and alpacas are members of the camel family, Camelidae, of which there are six living species. The ancestors of today's camelids evolved in North America between 9 and 11 million years ago. These creatures eventually died out in North America, but not before spreading to Asia and South America. They reached Asia via the land bridge that connected Alaska to Siberia. Today's Asian and African species are the bactrian (two-hump) and dromedary (one-hump) camels. When the Spaniards arrived in South America, they recorded four kinds of camelids. The wild forms are the guanaco (Lama guanicoe) and vicuna (Viama vicugna) or Lama vicugna). The domestic forms are the alpaca (Vicugna pacos or Lama pacos) and Llama (Lama glama). Despite their ability to interbreed and produce fertile offspring, each has been classified as a separate species. A debate on the separate genus classification of vicunas and alpacas has hinged on the fact that vicunas, and to some extent alpacas, have different dentition from Llamas and guanacos. Depending on an author's sentiments, scientific papers list vicunas and alpacas in either the Vicugna or Lama genus. Paleontologists speculate that the common ancestor for all four species predates today's wild forms by at least 20,000 years.

The four South American humpless camelids have much in common. They are ruminants, that is, cud chewers like cows. They are typified by long necks, slender legs, padded cloven hooves, large round eyes, and wool-covered bodies. All are extraordinarily alert creatures and can survive in places where it freezes most nights and forage is not plentiful.

Paleontologists believe the Llama was bred from the guanaco. The dentition and skeleton of both animals are almost identical. Individuals in both species usually weigh between 200 to 350 pounds (90 to 160 kilograms). Easily trained, Llamas make excellent beasts of burden. There are no wild Llamas. Subspecies of guanacos, which are wild, once roamed the Andes, but today they are found chiefly in the southern Andes, Patagonia, and in the continent's southernmost archipelago, Tierra del Fuego. In contrast to the Llamas, whose coloration varies, guanacos are always distinguished by a brown coat, a black or grey head, and evenly marked white underside. Both guanacos' and Llamas' woolly coats are usually riddled with coarse guard hair, which diminishes its commercial value. Llama fiber is commonly used to make ropes and textile products, such as potato sacks.

Alpaca dentition suggests that the animal is descended from the vicuna. Vicunas and many alpacas have no enamel on the tongue side of their incisors. These teeth are unique among large ungulates in that they grow continually. The animals regenerate their incisors after they are worn down from grazing stubbly grasses. Vicunas and alpacas are smaller than Llamas and guanacos. As the smallest of the four species, vicunas weight around 90 pounds (40 kilograms). They are the most delicate-looking members of the camel family and have large eyes. Usually found between 13,000 and 16,000 feet (4,000 and 5,000 meters), they live in stark, uncompromising environments far above the tree line.

Like the guanaco, the vicuna has uniform markings. The coat is cinnamon with a white underbelly and a light-colored head. The mensalis subspecies has a distinct white bib of hair hanging from its chest. Except for the bib, the vicuna's fiber is usually free of guard hairs and is exceptionally fine. For this reason, many connoisseurs consider it the most luxurious fiber in the world. A vicuna fiber is 10 to 15 microns thick (a micron is one thousandth of a millimeter) compared with 22 to 32 for alpacas and 25 to 70 in Llamas. Human hair, by comparison, often exceeds 100 microns.

Because of their valuable fleeces, vicunas were in danger of extinction from heavy poaching for most of this century. In the 1960s, the Peruvian government successfully moved to protect them, and today there are approximately 100,000 vicunas, most of them in the Peruvian highlands.

Alpacas (100 to 175 pounds, or 45 to 80 kilograms) are usually larger than vicunas, about half the size of a guanaco or Llama. Alpacas come in many colors and their wool is longer than vicunas'. At Inca Tops, a large Peruvian wool-processing mill near Arequipa, fleeces are separated into twenty-one colors in hues of black, brown, silver, caramel, red, coffee, white and fawn. Alpaca flee ces are categorized as huacaya (presence of crimp, a wavy quality that enhances its use in spinning and weaving) or suri (lustrous straight fiber with no crimp). About 90 percent of alpacas have huacaya fleeces. Known for its softness and lightness, alpaca fiber is second only to vicuna, which isn't readily obtainable since the skittish creatures do not take to domestication.

Alpaca fiber processing and production is a multi-million dollar industry in Peru, where 76 percent of the alpacas live. There are an estimated 3.5 million alpacas, 80 percent of them owned by traditional Quechua – or Arayama-speaking pastoralists in the highlands of southern Peru and Bolivia.

ARCHAEOLOGISTS have been able to date when camelids were first domesticated from camelid remains at sites once occupied by prehistoric man. Their estimates, still controversial, are based on subtle differences between alpaca and vicuna teeth as well as corroborative evidence.

Archaeologist Jane Wheeler of the University of Colorado at Boulder was the first to describe differences between alpaca and vicuna teeth. In 1984 at a dig in Telarmachay, in central Peru, Wheeler found a great number of camelid skeletal remains with dentition consistent with modern-day alpaca teeth. She interpreted this to be a result of controlled breeding practices, since only vicuna dentition was found prior to the discovery of the first alpaca remains. She also found a large number of skeletal remains of, or baby, alpacas, as well as remains of baby guanacos or Llamas. Wheeler reasoned that the number of skeletons had to be a result of domestication rather than hunting practices. From her work at Telarmachay, she concluded that camelid domestication was underway between 4000 and 5000 B.C. The dig also yielded, from an older layer in the earth, deer and vicuna bones, suggesting that these animals were important elements in the local diet prior to consumption of domestic camelids.

In the 6,000 years since domestication of alpacas and Llamas, a series of "high" cultures rooted in Andean pastoralism flourished and perished. Most of these cultures are known through archaeological site names. The earliest was centered around an ancient ruin called Chavin de Huantar in central Peru. The Chavin culture, which peaked in 300 B.C., left its mark throughout the Andes and coastal Peru in the form of immense stone figures depicting anthropomorphized eagles, hawks, jaguars, monkeys, and caymans.

Llamas were conspicuously absent from Chavin art, but very much part of their culture, according to George Miller, an anthropologist at California State University, Hayward. Miller specializes in the early pastoral cultures of the high Andes. "We know the Chavins ate a lot of Llama meat," says Miller, "but apparently they took their spiritual inspiration from animals more exotic than the Llama. The Llama was probably the Chavin equivalent to a Jersey cow or Toyota pickup."

Indeed, the appearance of tropical creatures in highland art clearly indicates that the highland culture had contacts with tropical Amazonia. In 1985 at an archaeological dig near the coastal town of Arica in northern Chile, a piranha jaw was found, evidence that trade routes actually connected the Amazon to the coast 5,000 years ago.

The Chavin culture was followed by the Moche and Nazca, and later Huari cultures, each dependent on Andean pastoralism and leaving behind characteristic textile products. The Pucara culture, which flourished near Lake Titicaca about 2,500 years ago, is thought to have bread the alpaca intensely for high-quality wool production, which was maintained by ensuing cultures. The Pucara textiles that have survived are among the most attractive hand-woven wool items ever produced in the region. Although there was no written language in these Andean cultures and no record of the size of herds or the volume of trade, anthropologists speculate that the trade surpassed all other prehistoric cultures in the Americas.

When conquistador Francisco Pizarro kidnapped the Inca leader Atahualpa for ransom, 26,000 pounds (12,000 kilograms) of silver and 13,000 pounds (6,000 kilograms) of gold arrived on Llama back in a period of a few months. On a single day in 1532, Spanish chroniclers recorded the arrival of 225 Llamas loaded with gold. This sorry episode, which resulted in the garroting of Atahualpa after payment of the ransom, provides one of the few recorded glimpses into early historic use of Llamas as pack animals.

Archaeological digs have produced similar examples of pottery, metallurgy, masonry, and religious shrines hundreds of miles from one another, demonstrating that ideas as well as goods were constantly moving throughout the areas served by Llama caravans in time periods long before the Incas.

In the 1400s the Inca Empire, also known as Tahuantinsuyu, meaning "four quarters of the world," began what would be the final pre- Hispanic Andean unification. The Incas eventually controlled what is now Peru, Bolivia, southern Ecuador, southern Colombia, northern and central Chile, and northwestern Argentina. This area took in 3,200 miles (5,000 kilometers) along the Andes, stretching from the Pacific to the Amazon rain forest, encompassing 20,000-foot (6,000-meter) peaks and the vast, harsh puna.

The Incas held camelids in the highest regard and carefully regulated both use of wild camelids and husbandry of domestic ones. Vicuna drives called chacos were conducted, with thousands of participants encircling wild vicunas and driving them into massive stone corrals, where they were shorn and released. The luxurious fiber collected was reserved exclusively for the ruling class.

Llamas and alpacas were central to Inca religious and ritualistic practices. In Cuzco, the Inca capital, a Llama or alpaca was sacrificed every morning, afternoon, and evening to honor certain gods and to mark annual events such as harvest time and birthing season of the herds.

Even though the Incas' domestic husbandry practices were never recorded in detail by the Spanish, available evidence points to a commitment to improve and keep separate the fiber qualities of the alpaca and the carrying capacity of the Llama. The scarcity of skeletons of Llama alpaca hybrid animals from the Inca period suggests that Llamas and alpacas were kept from interbreeding. Hybrid crosses are known today ashuarizos or waris. The reason for avoiding waris is that an intermediate-sized animal without the carrying capacity of a Llama or the fleece quality of an alpaca is not very useful. To this day traditional pastoralists usually butcher or castrate the larger males and keep them for packing.

The first Spaniards to enter the Inca Empire wrote of a large pack Llama used by the royal armies. Spanish chronicler Jose de Acosta described Llamas capable of carrying four to eight arrobas and arroba was equivalent to 25 pounds). If Acosta was accurate, the Llamas of the 1500s of this region were stronger than today's Llamas, which are usually hard-pressed to carry more than 100 pounds (45 kilograms) on a long journey.

The Spanish incurs ion severely disrupted native pastoralism, and with it, thousands of years of selective breeding. Chronicler Cieza de Leon wrote:

When the natives hid their flocks, the Spaniards tortured them with cords until they gave (the animals) up. They carried off great droves (of domestic camelids) and took them for sale at Lima for next to nothing. The soldiers and citizens took all the Indians' cloth and were selling it in the square at such low prices that a (Llama or alpaca) was sold at half weight. They were killing all the (Llamas and alpacas) of the land they wanted for no greater need than to make tallow candles. The Indians are left with nothing to plant, and since they have no cattle and can never obtain any, they cannot fail to die from hunger.

It's estimated that as many as two-thirds of the domestic camelids were killed off by the sword or by mange introduced from Spanish sheep and cattle.

"The Inca people weren't the only victims of the Conquest," says Miller. "The Spanish brought a kind of zoological imperialism, which altered forever the complexion of wild and domestic camelid populations throughout the Andes. Spanish horses, mules, sheep, swine, and dogs were spread across the Andean landscape carrying foreign diseases and competing with the camelids for prime grazing areas. The only survivors were those in marginal habitats where their evolutionary advantage allowed them to survive where European stock could not.

"IN THE EARLY 1970s, while Miller was doing field work on the puna between Lake Titicaca and Cuzco, he discovered intact many Inca beliefs and rituals involving camelids. Sensitivity and devotion similar to a kinship bond are strong among traditional herders. Miller relates the legend of Ausangate:

Ausangate is a magnificent snow-covered peak south of Cuzco and the legendary source of Llamas and alpacas. According to legend, Pachamama (Mother Earth) loaned alpacas and Llamas so the people of the puna could survive. Since the animals belong to Pachamama, they must be well fed and never treated cruelly. If they aren't properly cared for, Pachamama will call them back to Ausangate and people will disappear. Pastoralists believe that the ritualistic Inca method of slaughtering animals is the only correct way. In the method called cheilla two people hold the animal while an incision is made at the base of the rib cage. The person making the incision reaches into the chest cavity, pokes a sharpened fingernail through the diaphragm and pulls the aorta away from the animal's heart, killing it instantly. Quechua- speaking herders told Miller that this method is less painful than the European method of slitting the throat. As almost all bleeding occurs inside the animal's chest cavity, Pachamama is not stained with the animal's blood. The dying animal is covered with a blanket or shawl, so its spirit doesn't frighten the other animals. "When I asked why a particular animal was chosen, the herder often responded by pointing to a severe overbite or some other undesirable trait. Culling is part of the process," says Miller.

For Miller, Palacio, and other anthropologists recording the customs of highland herders, there's a feeling that the twentieth century is finally closing in on the traditional pastoralists' last strongholds in remote areas of the puna. "What the Spanish colonizers couldn't eradicate, the truck is making obsolete. Motorized transport and a rapidly expanding network of dirt roads are replacing Llama caravan routes. The new ship of the Andes is the transport truck that villagers load their goods onto once or twice a year," says Miller. "Many herders have sold their Llamas to slaughterhouses, and the last Llama caravan may not be far off. When that day comes, one of the great stories of animal domestication will end." Nevertheless, Miller hasn't entirely written off the future of native pastoralism: "Although the Llama's day may be ending, the alpaca, with its high- quality wool, will remain economically viable."

BEHAVIORAL TRAITS

Two Llamas competing over prime eating territory may exchange warning grumbles. If this doesn't settle the matter, they may asume threat postures, lifting their heads and tiling their noses skyward while pinning their ears back. Still unresolved, the conflict may explode into a contest of spitting and chest ramming.

South American camelids are a study in efficiency. They can get adequate nutrition from bunch grass with a protein content as low as 5 percent, much below the needs of most livestock (horses require grass with at least 12 to 14 percent protein). They digest and use food more efficiently than do most other ruminants. To thrive in the thin air three miles above sea level, camelids' red blood cell count is twice as high as that of most other animals; the elliptically shaped cells allow greater oxygen retention. The animals' padded, cloven hooves provide greater dexterity and gripping ability on treacherous rocky or ice-covered surfaces. Members of the camel family are natural pacers (the legs on the same side move in unison), which for moving across open spaces is the most efficient gait for a four-legged animal. By comparison, horses trot or gallop and must be trained to pace.

Among large ruminants, camelids' mating behavior and reproductive biology is unique. The females are "induced ovulators," which means they do not have a regular menstrual cycle. Females usually ovulate twenty-four to thirty-six hours after copulation. The male is a "dribbler," not an ejaculator like man and most other mammals. Coitus usually takes twenty to forty minutes with the male puffing his cheeks out and gurgling loudly. The very distinctive sound is called "orgling" by North American Llama and alpaca breeders and cutunco in Peru. Roughly eleven and a half months after mating, a single cria is born during the day.

Camelid herds are usually tranquil but ever alert. The animals move silently on padded feet and tend to communicate with body language rather than sounds. The sound most often heard is a soft humming, a mild expression befitting a gentle animal. Humming signifies insecurity during separation, slight discomfort, fear, or recognition.

PACA POWER

by Eric Hoffman

Eric Hoffman is President of Alpaca Owners and breeders Association and author of the Alpaca Registry. He's a professional journalist who's written over 200 feature articles for over 20 different magazines primarily on the subject of wildlife. His latest book, Adventuring in Australia, a 500 page travel guide, the first of its kind on the outback, will be published in the summer of 1990 by Sierra Club Books/Random House.

In the ranks of the North American camelid community there is a purposeful, dedicated and growing group who know the meaning of "paca power." They can act downright clandestine at times. Much to the befuddlement of other diners, a group of these was seen to lift their wine glasses and toast "paca power" in a restaurant at a recent Llama gathering. "Pacas" are, of course, alpacas and though some camelid owners may feel security in shrugging them off as nothing more than the run-sized cousin to the Llama, the "power" alpacas have commanded as a marketable, lovable and utilitarian animal has seen few, if any, parallels in the history of North American livestock. The market is in its infancy and it has already achieved a price structure that has taken decades to create with other animals. And, the alpaca market has attracted a host of players from the international livestock community as well as dozens of everyday citizens whose partiality, when it comes to camelids, is with alpacas.

To locate believers in "paca power", merely attend a meeting of the Alpaca Owners and Breeders Association. Be warned they are sometimes peculiar in how and when they meet. Last time they had a national meeting it started at 10:00 p.m. at the Salt Lake City, ILA Conference after the day's events had wound down. The meeting adjourned at 1:00 a.m. and though a few participants nodded off from time to time, only one person left the room while everything from joining an international wool association to affiliating with ILA and organizing a show committee was discussed. During the year AOBA meets telephonically in conference calls or communicates through Alpacas!, the organization's newsletter which was started by Cecile Champagne.

Known by its acronym, AOBA, the Alpaca Owners and Breeders Association is a small, farsighted and somewhat zealous organization. In short two years since they haggled through adopting their constitution and bylaws, they have created a vanguard registry – the first closed registry with verifiable lineage in the camelid world. The Registry boasts 95 percent of the national alpaca herd and representatives of the Alpaca Registry have already begun discussions that are aimed at incorporating New Zealand born and other foreign born alpacas into the Registry. AOBA continually forges its own direction dedicated to the triangular purpose of protecting, educating and promoting the special qualities of alpacas. The International Llama Association noted this trait when it awarded AOBA a Pushmi-Pullyu Award at the 1989 ILA Conference in Salt Lake City. The International Lama Registry noted this when the ILR BOD indicated on December 2nd, their commitment to adopt the essence of the Alpaca Registry for Llamas.

Unlike Llamas, alpacas are a brand new animal for North American animal aficionados. Llama origins in the U.S. have been traced to the Central Park Menagerie (now defunct) in New York City to a time shortly after Abraham Lincoln was President. It's fair to assume "The Great Emancipator" never turned his attention to the plight of Llamas. Freedom for Llamas from the confines of zoos to trekking on High Sierra trails and prancing across Fred Hartman's auction ring didn't come for more than a hundred years later. The alpaca story in the U.S. doesn't require an historical perspective – most of it begins during Ronald Reagan's watch.

According to the San Diego Zoo's records of North American zoo inventories, alpacas were scarce in the U.S. and Canada until very recently. In 1984, the import partnership of Tom Hunt and Jurgen Schulz brought in 270 alpacas from Chile, and David Mohilef, the owner of the Pet Centre, brought in 150. Prior to this a South American importation by Irv and Bea Kesling , a couple dozen English alpacas brought in by Dick and Kay Patterson, and zoo animals had served mainly to wet the appetite of would-be alpaca owners. With a 240 alpaca importation by Hunt and Schulz in 1988 and the healthy birth rate of national herds, the Alpaca Registry now records about 1,500 alpacas in the U.S. and Canada.

Just why alpacas seem to be generating their own energy field depends on who you talk to. Certainly the relatively small numbers of animals to supply increasing demand strengthens the market, but numbers alone don't explain it. Importer Tom Hunt: "Alpacas are an excellent animal for discriminating animal buyers. The market and enjoyment these animals generate has not fully developed." Jurgen Schulz, Tom Hunt's partner, says, "Considering the short time alpacas have been available, they've proven to be stronger in the market than we had anticipated." Relative newcomer to alpacas Antoinette Brewster of Charlottesville, Virginia explains why she took the plunge after first establishing a Llama herd. "Alpacas have everything: strong aesthetic appeal, easy manageability and an elegant fiber, which is an end use that appeals to a great number of people." Brewster adds, "On a daily basis I love them because you don't need machismo to manage them. Their small size and agreeable dispositions aren't threatening to me. I've noticed women are attracted to alpacas." Dr. Ralph Uber of Yakima, Washington, a long time alpaca owner simply says, "If you can't get enthusiastic about alpacas, what can you get enthusiastic about?" Mike Safley, one of the more active members of AOBA printed up bumper stickers with the slogan "Alpacas: the finest livestock investment." One corner of the sticker has a replication of the International Alpaca Association's (AIA) logo, the "Golden Mark," a stylized drawing of an alpaca that goes on every label of verifiable alpaca products marketed worldwide. Safley mailed his bumper stickers to members of AOBA free of charge.

Testimonials, rationales, conversions and sales pitches aside, there wouldn't be any alpacas for twentieth century North Americans to contemplate if it weren't for Andean pastoralism – the ancient system of animal domestication that created for the world both the Llama and the alpaca from selective breeding practices. The two animals have parallel histories but were apparently domesticated for different reasons. Despite their similarities, Llamas and alpacas have different ancestries. Maintaining the unique qualities of alpacas that took centuries to develop has become a rallying cry among alpaca owners. These sentiments are manifested in the strongly supported Alpaca Registry.

Alpacas can be considered the oldest livestock in the Americas. Alpaca dentition strongly suggests that they descended from the vicuna (Vicuna vicugna), the fine fleece wild camelid, found only in the most remote and highest parts of the Andean highlands. Both animals are roughly the same size, usually between 90 and 140 pounds. Vicunas and alpacas have no enamel on the tongue side of their incisors. Both animals have the capability of regenerating their incisors and there is an absence of permanent roots in these teeth. These teeth are unique among wild ungulates and they are thought to have evolved as a survival strategy. A vicuna's reliance on a diet of herbs and short cropped grasses causes teeth to wear down rapidly. Continually growing teeth have allowed the animals with them to survive longer, giving them a reproductive advantage over animals with less advantageous dentition. It is thought that alpacas merely inherited their teeth from their vicuna predecessors.

Though the species have similar teeth, there are subtle differences between alpaca and vicuna teeth that have conveniently helped archaeologists in piecing together the prehistory and history of alpacas.

The business of studying camelid teeth has contributed greatly to dating the domestication of camelids and understanding why a series of pragmatic pre-Inca cultures went to the trouble to domesticate two separate species. Understanding the differences in camelid teeth may ultimately help end the debate on how to go about classifying camelids whose phenotype makes it unclear if their ancestry is alpaca of Llama. 'Simply stated, alpacas and vicunas have regeneration incisors with no enamel on the tongue side of their teeth. Guanacos and Llamas have identical dentition with permanent adult incisors encases in enamel front and back. Llamas are thought to have descended from guanacos since both animals dentition are identical and they are similar in many other ways.

Dr. Jane Wheeler of the University of Colorado at Boulder has made great contributions in this area. She took understanding differences a step further when she found differences between vicuna and alpaca teeth. In 1984 at a dig called Telarmachay high in the Andes, Wheeler made a remarkable find. She discovered large numbers of ancient camelid skeletons at sites used by prehistoric man. The teeth in the skeletons she found were consistent with modern day alpacas which have subtle differences from vicunas. Wheeler interpreted her find to mean controlled breeding had taken place, since only vicuna dentition found prior to the discovery of the alpaca remains. From her work at Telarmachay, Wheeler concluded alpaca domestication was well underway by 5000 B.C. Llama domestication is thought to have paralleled alpaca domestication, though the evidence is more circumstantial.

Since her original research Wheeler has become so convinced that alpacas are closely related to vicunas she is proposing the genus name of alpacas be changed. Presently many scientific publications list Alpacas as Lama pacos the same genus as guanacos (Lama guanicoe) and Llamas (Loma glama). Only vicunas (Vicuna vicugna) have an universally accepted separate genus. Definition has long been means of distinguishing between species. Largely due to Wheeler's recent work, alpacas may become officially known as Vicugna pacos, which will separate them in the scientific community from Llama and guanacos.

In the next 6000 years since domestication of alpacas and Llama a series of "high" cultures rooted in Andean pastoralism flourished and perished. Llama served as the best of burden and wool source; alpacas were shorn for their high quality fiber. Both animals were butchered. This level of domestication guarantees a steady source of meat, high quality textile fiber and a means to move large amounts of goods through rugged mountain areas. The Chavin, Moche, Nazca and later Huari cultures were each dependent on Andean pastoralism for their survival. The Pucara culture which flourished near Lake Titicaca about 2,500 years ago, is thought to have bred the alpaca intensely for high-quality wool production, which was maintained by ensuing cultures. The Pucara textiles that have survived are among the most attractive hand-woven wool items ever produced in the region. Although there was no written language in these Andean cultures and no record of the size of herds or volume of trade, anthropologists speculate that the trade surpassed all other prehistoric cultures in the Americas.

In the 1400's the Inca Empire became the last great pre-Spanish culture dependent on Andean pastoralism. Even though the Inca's domestic husbandry practices were never recorded in detail by the conquering Spanish, available evidence points to a commitment to improve and keep separate the fiber qualities of alpaca and the carrying capacity of the Llama. One Spanish chronicler described Llamas capable of carrying 200 pounds and an elite Inca herding class responsible for the management of the royal herds. The scarcity of skeletons of Llama-alpaca hubrid animals from the Inca period suggests that Llamas and alpacas were kept from interbreeding Hybrid crosses, known today as huarizos or waris, lacked the carrying capacity of Llamas and the fiber quality of alpacas. Such an animal would not be useful. To this day, the descendants of the Incas, the traditional Quechua and Aymara speaking pastoralists, often butcher waris or castrate the larger males and keep them for packing. After the Spanish conquest much of the order established over centuries old husbandry practices was disrupted and has never fully recovered.

Primarily because of their high quality fiber, alpacas are a viable economic resource in South America today. The South American herd population is estimated at 3,500,000 animals with 90 percent of them residing in Peru. Shearing, sorting and readying alpaca fiber for the international market is big business incorporating 35,000 breeders in Peru and large fiber processing mills such as Inca Tops in Arequipa, Peru. Inca Tops processes 60 ton annually while sorting wool into as many as 20 different natural colors and tones, as well as five different categories of fineness. Generally alpaca fiber is free of guard hair and falls between 20 and 32 microns in thickness (a micron is one thousandth of a millimeter). The predictable uniformity found in large numbers of animals sets alpaca fiber off from Llama fiber which usually ranges from 25 to 70 microns and often contains varying degrees of unwanted guard hair. Among South American camelids, alpaca fiber is second only to vicuna (10-15 microns) which isn't readily obtainable since the skittish creatures do not take to domestication. Surprisingly, vicuna fiber contains thin guard hairs. Alpaca fleece are categorized as huacaya presence of crimp, a wavy length that enhances its use in spinning and weaving or suri (lustrous, straight fiber with no crimp). About 90 percent of alpacas have huacaya fleeces. There are no known true suris in North America. However, there are a half dozen chilis, which are animals possessing an intermediate fleece that is suri-like in appearance but usually not as fine.

Alpacas are generally solid colors and are recognized as coming in eight basic colors: white, black, silver (or grey), red, coffee, caramel (gold), fawn and piebald (multicolored on the body). White is the preferred color by large commercial entities in South America because it can be more readily dyed. However, all of the eight basic colors are marketable to natural fiber markets and are used in products woven at home by Quecha and Aymara speaking pastoralist. From the basic colors, fleece (or animals) can be sorted for subtle tones. For example, silver animals come in rose grey, blue silver, charcoal grey, etc. Susan Stackhouse of Hughson, California says, "The colors of alpaca fiber are astounding in terms of their breadth and beauty." Her personal favourite is caramel, a rare color in the U.S.

How the uniform, luxurious qualities and magical hues and colors of alpaca fleeces play in the budding North American alpaca market isn't entirely known yet, but measures have been taken to preserve fiber quality and not allow them to be eroded by Llama or huarizo crosses entering the gene pool. The Alpaca Registry's reliance on blood typing that ties offspring to their parents provides this safeguard.

To date there have been no large alpaca show/sales similar to the Hartman format. (There have been a few "sidebar" show/sales in which a lpacas were used to supplement a Llama sale.) Successful large alpaca sales have been conducted by Bonny Doon Llamas and Alpacas (representing Camelids of Delaware, a Hunt/Schulz company) in the U.S. In these sales, Peruvian standards have been applied to a range of alpacas with prices assigned them according to the relative quality of a particular animal. Fiber quality, soundness, reproductive potential, dentition, age, color and presence contributed to the price. In the sale of 130 alpacas the average sale prices have been $8,500 for male weanlings; $17,000 for weanling females; $29,000 for adult females; and $28,000 for stud quality adult males. The high price for an alpaca sold at these sales was a male named Bravo Bravo who sold for $60,000 and now belongs to

Edna Kennedy of Santa Fe, New Mexico. The top selling female, Vicuna Legacy, was sold to Evelyn Sharp of Aptos, California for $45,000. In the alpaca market the structurally sound, fine fibered, vicuna looking phenotypes, such as Vicuna Legacy, have drawn top dollar which contrasts to the Llama market that often maligns wild guanaco-like markings. At the lower end of the market, pet quality alpaca males sell for $2,500. Besides a few large sales there is a lively private treaty market. The largest known single transaction involved the purchase of the Truckee River Alpaca Ranch herd of ten females, Bravo Bravo and other males for $370,000 by Edna Kennedy.

AOBA is currently working to establish a show format that involves input from the entire AOBA membership. Michael Safley, who heads up the Show committee says, "Fiber will definitely be an important component as will soundness." Safley adds, "A novel approach being talked about by some members of AOBA is to have show contests within the eight basic alpaca colors. This way we get more champions, broader participation and keep our gene pool broadly based. Most other livestock industries tend to pick a single champion who then dominates the gene pool. I personally see advantage in avoiding this kind of thinking." Tom Chamlee, a proponent of the eight color categories of showing, feels show standards should welcome diversity. "Every alpaca breeder, large or small, should have a place to show. Old animals, young animals, shorn animals, animals with full coats and animals of all colors should have their place as long as fiber quality soundness and alpaca characteristics are not forgotten.

" Anthony Stackowski, the first large investor in alpacas (aside from the importers), has strong feelings about shows. Stackowski is a veterinarian and former Arabian horse judge. Stackowski: "I'd like to see judging breakdown about fifty percent on fiber which would include coverage and quality. I'd assign about forty percent of judging to conformation and the last ten percent to presence and manners. Judges must be highly qualified in their knowledge of alpacas." Stackowski cautions that the alpaca community should avoid the pitfalls of other livestock judging. "I feel we need regional shows to qualify for one national show per year. I am against accumulating points at local or regional shows for a champion of the year. It becomes a "trailer race" i.e., time and money will be recognized, not the best quality alpaca in most cases."

While alpaca owners define the qualities in their animals that they feel are most important, some of them have taken a more hands-on approach. Evelyn Sharp, former sheep owner, has made it her business to learn how to shear alpacas. After shearing her own animals and her neighbours animals, she feels both technology and technique need refinement. "Alpacas respond differently than sheep. Basically they are smarter and more sensitive. The y are best shorn standing and the shearer should work slowly. We use horse clippers, not sheep clippers which can grab and tear the flesh. However, we haven't found a perfect blade yet. Alpaca fiber is too dense for horse clippers and we have yet to find the perfect clipper. The ultimate blade may have to be invented. "Sharp feels detailed knowledge of fleeces and how to care for them is at best in the formative stage. "We've found certain colors have different characteristics in terms of fineness. However, we don't know if we've shorn a large enough sample to make any hard and fast rules. We also think methods of keeping fleeces clean must be perfected. Top sheep are often outfitted with coats to keep their fleece clean prior to shearing. I'm not in favor of that for alpacas, but we need to come up with methods to keep debris out of fleece, if we are going to become serious about commercially harvesting fiber." Sharp has clipped on the average of about five pounds annually from the alpacas in her area. An alpaca with a four year growth yielded 12 pounds of fiber. Gretchen Quigg, an Oregon based alpaca breeder, has sold high quality, clean fleeces for $400 a piece to weavers and fiber outlets. Meanwhile AOBA has made overtures to International Alpaca Association to see how to go about becoming part of the international wool market.

Other alpaca owners have put their efforts into research. Antoinette Brewster chairs AOBA's Research Committee. She recently sent out a 25 page questionnaire to the AOBA membership that is aimed at understanding and improving alpaca health care and management. "We need to get some base line data before we can figure out what our research priorities should be. We need to know what areas of concern are specific to alpacas or shared with Llamas." Joan Spiers of Solvang, California, another member of the AOBA's Research Committee, feels research is the single more important area for focus: "Alpacas are a new animal and there are subtle differences between them and Llamas. We need to understand them better in order to give the best possible care." This kind of diligence has brought new information to light for the entire camelid community. Rickets in camelids was first identified in an a lpaca in 1988 and later found to occur in Llamas.

The international livestock community has definitely focused on alpacas. New Zealand has led the charge with five separate exportations of alpacas from Chile. European nations are now applying for a s lot in the Chilean rotation of exporting countries. Chile has set a ceiling of no more than 1,200 camelids being exported annually to anywhere in the world. The fact that exporting nations are primarily interested in alpacas instead of other camelids is seen as a healthy endorsement of alpacas. Drew Duncan who represents two New Zealand entities says "We'll be shipping crias to Canada on an annual basis." Duncan claims the maximum number of crias entering Canada from New Zealand in 1990 will be about 60 animals. He predicts maximum number in later years will be around 180 animals which will amount to about 17 percent of the annual cria crop of the North American herd. Tim Hunt and Jurgen Schulz whose herd exceeds 250 animals aren't overly concerned about New Zealand's entry into the North American market. Tom Hunt: "The New Zealand animals will probably serve to stimulate more interest. The numbers aren't great enough to adversely impact our market. Crias coming into Canada from abroad in 1990 won't be reproductively competitive until 1993." The New Zealand born animals can't be imported into the U.S. but their offspring can.

As the shakers and movers in the alpaca market do their thing, there are plenty of folks who just enjoy their animals for no other reason than their purely alpaca qualities. Arnie Feldsher of Sonoma, California looks out his window in one direction and sees vineyards and in the other direction he has a pasture dotted with alpacas. "To me they are living art as well as wonderful animals," says Feldsher. Vicki Morris of Florissant, Colorado bought two pet quality males because, "I fell in love with their cuddly looks and personalties. We didn't buy them for investment, but rather for the pleasure of owning them. T hey are so endearing. We get more attached every day."

"Paca power" is a different thing to different people, but to all of them there is a shared excitement and anticipation of owning an animal whose place in North America is only beginning to be appreciated.

ALPACAS

The sight of mountains and rolling grasslands may look like home through the eyes of the young alpaca born at Tara Hills, but for the other 75 alpacas at the MAF Technology research station, it is far from their native Chile.

Otago's first alpaca flock arrived at Tara Hills in September 1989, after several months of travelling and quarantine, and immediately took to their new surroundings at the high country station. The "altiplano", or high plateau, where they originated has an altitude of 4000 metres, and can be extremely cold, but its dry climate and feed conditions are comparable with inland Otago. Alpacas like to browse on fibrous pasture and shrubs, so Tara Hills should suit them.

Alpacas are close relatives of the Llama, and come in colours ranging through grey, black, brown and white. Long necks aside, they look more like a sheep than any other New Zealand animal, but have some very unusual characteristics. If they do not want to go somewhere, they will simply sit down and refuse to budge, and when agitated, they spit. The alpacas also form dung heaps in certain parts of their paddocks, and love dust baths. However, they are appealing looking animals, which is obviously why they are in big demand as pets in the fashionable circles of Los Angeles. Their fine wool is similar to that of a medium Merino or Corriedale sheep, ranging between 22 and 32 microns depending on nutrition, and is remarkably soft and three times stronger than wool.

Some alpaca meat is available in Chile, but it is the valuable fibre especially the white fibre that is internationally sought after. It can fetch anything from $70 to $150 a kilogram as it is in big demand for the luxury apparel market.

While MAF's research will be concentrating on improving nutrition and studying alpaca growth and production over the next few years, its long term plans involve the development of a new fibre industry for New Zealand.

However, alpaca production in New Zealand is still at the very early stages, but comparable to the deer industry as it was 20 years ago.

One of the key objectives of the research is to find out what effect nutrition has on alpaca breeding. Their barrenness, up to 70 percent in some parts of Chile, is well publicised, but it is believed this high barrenness is almost certainly related to poor nutrition. Mature alpaca weigh around 65 to 70 kilograms, but in the harsh environs of Chile, the hardy animal may weigh as little as 35 kilograms, which could put some stress on animal breeding.

Government regulations make it impossible to buy only white alpaca from Chile. Consequently MAF has only five white males, but it hopes to breed more, although there are difficulties with that idea. "Putting a white male with a white fe male alpaca, does not necessarily result in a white offspring." Furthermore, an 11 and a half month gestation period, and no twins, means increasing flock numbers at Tara Hills will be a slow process.

The alpacas are farmed on 40 hectares fenced by Tara Hills staff, and as an extra precaution, 25 of MAF's alpacas are on a property in Lowburn, Central Otago, which is outside the endemic TB area.

Alpaca farming New Zealand style is a far cry from the Chilean system where small flocks free-range on the plateau, but are herded into corrals overnight by the Aymaran Indians who own them. The Indians seem to have an almost spiritual attachment to the alpacas, and only clip the fibre as they need money. The alpacas found the New Zealand method a new experience, as shearing on the altiplano was carried out with scissors, bits of glass, or any other sharp object.

The animals are expected to adapt well to the dry inland environment at Tara Hills, and the MAF research team are looking forward to finding out how the improved nutrition will affect alpaca growth and production over the coming years.

PROFITABILITY OF RAISING ALPACAS IN SMALL AREAS

by Jim Falks Dec. 1990.

A. Introduction: Profitability is simple; income must be greater than expenses period. Usually a function of supply/demand (which can be fickle).

1. The alpaca supply is limited.
2. Demand is influenced by The Alpaca Advantage.

B. Tangible advantages in raising alpacas as livestock.

1. Low numbers – high return: 2 pair alpacas for $30,000 = $15,000 gross annual income. $30,000 buys 3,000 sheep = $50,000 gross income in wool, but 1,000 acres of land ($1,000,000 land) – the annual land cost is $150,000. Land intensive.
2. Low impact on the land (Earth Friendly)
   a. small numbers
   b. efficient eaters
   c. consolidated feces
   d. padded foot
   e. low water consumption
   f. don't debark trees
   g. clear weeds (devil's club)
3. Disease resident – lower insurance and vet costs.
4. Adaptability to habitats – Alaska to Billy Island – no worry – breed in airplane.
5. Unique, rare fleece as by-product (not so with pot belly pigs).
6. Safe – no horns – can't hurt you (ostriches).
7. Minimum fencing.
8. Intelligence – ease of handling/training.
9. Useful – lawn mower, pet, packing, wool production.
10. Insulated from oversupply.
11. Ease of shipping to world markets (diversification).
12. Clean – feces, travelling.
13. Relatively long reproductive life span.
14. Insurability.
15. Liquidity.

C. Tax Advantages

1. Business deduction for farming lifestyle.
2. Wealth grows in geometric proportions without tax until sold.
3. Self employed – in control of your life.

D. Intangible Advantages

1. Personal satisfaction of animals vs. file cabinet.
2. Healthy Lifestyle.
3. Don't have to kill to profit.
4. Earth friendly vocation – one of the world's most practical animals.

E. Disadvantages

1. Can't lock them up in a file cabinet and go on holiday.
2. Risk infertile female.
3. Because they are rare and different Vet care could be a problem.
4. High value might encourage pinching.
5. Non-essential commodity – collapse of world economy (yet alpaca is still food, fuel, clothing and transportation).

F. Return on investment – Arms length/meet test of the steel eyed banker.

1. Assumption:
   a. purchase 4 adult females and 1 male
   b. maintenence costs at 300 per animal
   c. wool production at 2 kg per year equals approximately $120 net per animal
   d. sales prices remain constant
   e. 75% live birth rate beginning with 2 males and 1 female
   f. animals are insured for full mortality at a cost of 4.5% of value

INVESTMENT ANALYSIS

Objective: Sell offspring each year for 5 years, then liquidate herd.

Investment:	4 adult females at $15,000 each	= $60,000
	1 adult male at $10,000	= 10,000
	Fencing and improvements	= 5,000
	TOTAL INVESTMENT	$75,000

	1991	1992	1993	1994	1995
Income:					
Sale of males		$15,000	$7,500	$15,000	$7,500
Sale of females		$15,000	$30,000	$15,000	$30,000
Sale of wool	$600	$600	$600	$600	$600
Total Income	$600	$30,600	$38,100	$30,600	$38,100
Expenses:					
Maintenence	$1,500	$1,500	$1,500	$1,500	$1,500
Insurance	$3,150	$3,150	$3,150	$3,150	$3,150
Total Expenses	$4,650	$4,650	$4,650	$4,650	$4,650
Net income	($4,050)	$25,950	$33,450	$29,950	$33,450
Return on Investment	(5.4%)	34.6%	44.6%	34.6%	44.6%

5 year return after liquidation – net income $109,750 = $21,950/yr = 29.2%/yr.

CASE HISTORY

Feb-1985 Purchased	4 adult females at $12,000	= $48,000
	2 Adult malesat $20,000	= $20,000
		$68,000

6 years later

December 1990 Amount available for sale:

8 males	at $10,000	= $80,000
10 females	at $12,000	= $120,000
1 male cria	at $10,000	= $10,000
5 female cria	at $12,000	= $60,000
27 Alpacas		$270,000
LESS INVESTMENT		$68,000
GROSS INCOME		$202,000
LESS EXPENSE		$15,000

$187,000 Divided by 6 years = $31,166

Divided by investment of 68,000 = 45% annual return on investment Plus income from all Wool sales.

Preventative Health Care

by Bradford B. Smith, DVM,PhD and Patrick Long, DVM

Preventative health care is just that – avoiding problems before they develop. The most important step in developing a preventative health program for your herd is to establish a routine and then stick with it. The first step is to grab your calendar and mark out two or three days per year at 4 to 6 month intervals that you can spend working with your animals. On these days you are going to carefully examine each animal, trim feet, vaccinate and deworm. Plan on spending a minimum of 15-30 minutes on each animal. The second step in developing your herd health plan is to be systematic. It doesn't really matter whether you worm first or last – just establish a routine and then handle each animal in the same manner. By doing it this way, each animal is carefully examined and treatments aren't missed.

WHOLE ANIMAL

Start by steeping back from the animal and objectively looking at your Llama. The first question to ask is – "Is the animal's weight reasonable?"

You want to avoid animals that are too thin or – as is all too frequently seen – too fat. A good way to check weight is to run your hands down the animal's spine. You should be able to feel the top of each vertebrae. Then run your hands along the animal's ribs. The animal that is too thin will feel boney and may not be as active as others in the herd. You want to avoid the extremes at either end – the 150 and the 550 pound adults.

Unfortunately, accurately judging an animal's weight is as much an art as it is a science. Differences in wool thickness, bone structure of the animal, etc. can all affect the accuracy of your estimate. One of the most useful pieces of equipment you can buy for your farm is a good set of scales. n addition to helping you judge weight, you veterinarian will thank you since it makes computations of drug dosages far easier and significantly more accurate.

There are a variety of reasons why you don't want an overweight animal. In addition to subcutaneous fat deposits, fat is also deposited around the internal organs, especially the heart and kidney. Excess fat can damage normal organ function and shorten and animal's life. In addition, although a clear cut cause and effect relationship has not been established, excess fat seems to predispose animals to reproductive problems. Fat mothers seem frequently produce insufficient milk. Work in the dairy cow has shown that overfed heifer calves deposit excess fat in their maturity, the animals' mammary glands never fully develop due to the fat deposits. It seems reasonable to suspect that the same situation applies to the Llama.

DIET

In spite of the popularity of Llamas in North America, we still really don't know their true dietary requirements for normal growth and development. A good rule of thumb is that a Llama will eat 1 to 2% of its body weight per day. Remember, these are just guidelines. Base your final feeding decisions on how the animal looks. For a 350 pound male this would be 3.5 to 7 pounds per day of quality alfalfa. In addition to being expensive, animals fed just alfalfa tend to be overweight and frequently grow too rapidly. Another problem is that very rapidly growing young animals appear to have more bone and joint problems than more slowly growing youngsters. The female in late pregnancy, debilitated older animals and significantly underweight animals do require more food according to the animal's weight.

DON'T OVERFEED YOUR ANIMALS

Vitamin and Mineral Supplements: Relatively little is known about the dietary vitamin and trace mineral requirements of the Llama. A free choice granular trace salt mix should be available to the animals at all times. The granular salt mix seems to be better accepted than the block type salt mix used for other livestock species. Thee need for supplemental vitamin and selenium varies by area. In selenium deficient areas, such as much of the northwest, supplemental vitamin E/selenium should be administered by injection 2 to 3 times per year. Again, the amount and frequency of vitamin E/selenium supplementation is based on work in other species. The true vitamin E/selenium requirements in the Llama are not known. Check with your local vet and/or producer group to determine if your area is vitamin E/selenium deficient. As part of your preventative health check, give vitamin E/selenium if necessary and check the salt mixture. Make sure your animals are actually eating it.

Don't however, overdo the vitamin E and selenium. Excessive selenium can be toxic.

Feed Analysis: Although not widely done, consider getting a feed analysis when you purchase large amounts of hay. A feed analysis will tell you the amount of protein and calcium and phosphorous concentrations in the hay. If you live in a selenium deficient area, vitamin E and selenium determinations should also be done. This information will help you and your vet formulate a balanced diet for your herd. When collecting a feed sample for analysis, it is important to get a representative sample. To do this, split open several hay bales and take a small sample from each bale. Your vet or local extension agent can tell you how to submit samples to a testing lab in your area.

SKIN AND WOOL

Still looking at the whole animal, the questions to ask are:

a). Does the animal have any thinning or bald spots?

b). Is the animal scratching?

c). Is the wool coat too long?

The most common skin problem in the Llama is lice. There are two types of lice frequently found on the Llama /173 biting lice and sucking lice. An unusually itchy animal is frequently the first sign of a lice problem. Lice feed by either biting the animal repeatedly or actually attaching to the Llama and sucking. Both types of lice, however, will cause the animal to rub and roll. Although they look rather different under the microscope, in real life both types of lice look like a small flake of dirt or a piece of rice. To check for lice, start at the animal's head and slowly move to the tail carefully parting the wool and looking at the skin.

Lice look like small parts of moving dirt and are usually seen just above the skin. If the animal has sucking lice, treatment with ivermectin will usually be effective. Biting lice are treated with organophophate insecticide dusted or poured onto the animal. The insecticide can be toxic, is rapidly absorbed through the skin and should only be used by your vet.

Wool colour and length is a major topic of discussion in the Llama industry. From a health perspective, there are times when shearing the animal is in the Llama's best interest. Some Llamas have difficulty with high temperatures and will suffer from heat stroke. If you live in a hot region, make sure the animal has plenty of water, shelter from the sun and. consider the possibility of shearing the animal.

HEAD AND MOUTH

Start with the head and carefully look at the eyes, ears, nose and mouth. The eyes should be clear and free of debris and parasites. If significant discharge is seen from the eyes, ears or nose, call your vet and have him/her examine the animal.

The teeth should be carefully examined each time you check the animal. Gently lift the animals lips and look at the teeth. the fighting teeth normally erupt at 2 1/2 to 3 years of age in the male and 4 to 5 years in the female. In general, when the fighting teeth project more than one inch beyond the gum line should be cut off. Most veterinarians and producers use 'gigli-wire" for this purpose. the fighting teeth will, however, re-grow and it is not unusual to cut them off again 2 to 4 years later. Remember there are two fighting teeth on the top and one on the bottom on each side Check to make sure you have found them all. Also check for any unusual areas of swelling or sensitivity in the oral cavity. Tooth abscesses, small infected wounds, etc. are occasionally found. if anything abnormal is found, call your vet.

FEET

Next take a look at your animal's feet. Most Llamas periodically need to have their toenails trimmed. The frequency of feet trimming varies tremendously, however, with the individual animal and pasture conditions. Hoof wear is slower in animals kept on soft fields and nails will need more frequent attention than if the animals are kept on harder abrasive ground. If the nails need trimming, a pair of sheep hoof trimming shears works well. Trim the tip of the nail and then both sides (see photos). If a Llama's feet have been neglected for a long time, however, correcting the abnormal nail growth can be difficult. Even after four trimmings, the foot shown in the photo is still clearly abnormal. While trimming your animal's nails, also check for any unusual abrasions, cuts, abscesses, etc.

INTERNAL PARASITES

All animals, including Llamas, have internal parasites. There are three general groups of internal parasites that should concern Llama owners. The most common and important group of internal parasites are the round worms of the genus Nematodirus, Camelostrongylus, Cooperia, Trichostrongylus and Trichuris. Adults of the different species live in the abomasum, small and large intestines and cause extensive damage to the gastrointestinal tract. Heavily parasitized animals frequently don't grow as rapidly as animals with low numbers of parasites although even a few parasites can significantly slow an animal's growth. In animals with large numbers of intestinal parasites, the damage can be extensive.

The second major group of internal parasites is coccidia. These are very small intracellular parasites and usually produce diarrhea. Diagnosis and treatment will require professional assistance. The final group of internal parasites is the liver flukes. The flukes have a complicated life cycle that includes a snail living in damp or marshy areas. The adult flukes live in the liver and can cause very extensive damage. The same fluke that infects sheep and cattle can also infect the Llamas.

A practical way to evaluate the efficacy of your deworming program is to collect fecal samples from 6 to 8 of your animals at least once a year and submit them to your local vet. In larger herds, it is recommended that fecal samples be collected from 10% of the herd. Using special techniques the sample will be checked for parasite eggs (ova). By counting the type and number of eggs per gram of feces, it is possible to make an estimation of the parasite load in the herd. Frequent worming is not, however, a guarantee that you will get rid of all internal parasites. Even under optimal conditions expect your vet to find some eggs. Egg counts of less than 100 ova per gram are generally considered to be indicative of an effective worming program. Since the diagnostic test used for the detection of liver flukes is different than the one used for round worms, specifically request that your vet check for flukes if they are a significant problem in your area.

Deworming: Routine deworming and vaccinations are the two most important aspects of a preventative medicine program. For most parts of the country, deworming Llamas twice to three times per year seems to be adequate for parasite control. The major widely used dewormers are ivermectin (Ivomec-TM), the benzimidazole family of dewormers (Panacur - TM, TBZ - TM and Telmin - TM), levamisole (Levasole - TM, Ripercole L - TM, and Tramisole - TM) and pyrantel palamate (Strogid - TM). Alternate the family of dewormer you use. Parasites can develop resistance to a particular class of dewormers, for example the benzamidazoles, if used repeatedly for a long period of time. An effective program used by a large number of Llama owners in the Willamette Valley of Oregon is to deworm with ivermectin in the spring and then use a benzimidazole (e.g. Pancur - TM) for the second deworming in the fall. Deworming your animals is easy. The least traumatic method for the Llama (and owner) is to use one of the oral pastes. The dewormer comes as a paste in a tube resembling a caulking gun. The dewormer is placed in the corner of the mouth and given according to weight. In most cases the dewormer is sticky and will be swallowed by then animal. Only occasionally will you end up wearing a small amount of dewormer. Some dewormers (ivermectin and levamisole) can also be given by injection into the relatively wool free area at the back of the rear leg.

VACCINATIONS

Routine vaccinations are a must. At minimum you should vaccinate your animals at least every year for tetanus and Clostridium C and D. Vaccinations for young animals are started at 3 to 4 months of age and a booster injection given 4 to 6 weeks later. Following initial immunization, yearly boosters are given.

Both pregnant and non-pregnant animals need immunization. An excellent time to treat the pregnant female is one month prior to giving birth. Treating at this time helps provide early immunization for the cria. Animals can also be dewormed at this time is necessary. Organophosphate treatment for lice should be avoided at this time.

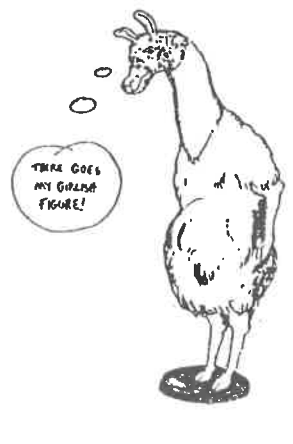
Most Llamas are not routinely vaccinated for rabies. In areas in which the incidence of rabies is high, Llamas have been safely vaccinated with the killed rabies vaccine. It is important to remember, however, that the rabies vaccine is not specifically approved for use in the Llama. The modified live vaccine should never be used in the Llama. Check with your local veterinarian for recommendations.

The use of other Clostridal vaccines should be considered (C. chauvoei, C. novy, and C. septicum) if liver flukes are a problem in your area, if cattle or sheep graze nearby, or if cattle or sheep have been in your pasture in recent years. With the use of the readily available seven way Clostridiumtoxoids, your animals will be protected against all of the common Clostridal agents. Again, consult your local veterinarian for recommendations.

A relatively new concern for Llamas and alpacas is the equine rhinopneumonitis virus (EHV - 1). The virus has been incriminated in several recent cases of blindness in the Llama and alpaca. Currently little is known about the ease of transmission, the susceptibility of the Llama to EHV infections and its duration or effect. If your Llamas are in contact with horses, this is another vaccine to consider. Again, consult with your local veterinarian.

Leptospirosis can be very serious disease in the Llama causing abortions and other problems. It is, however, only very rarely a significant problem and it is not recommended that herds be routinely vaccinated for leptospirosis.

Thanks to Dr. Gary Zimmerman, College of Veterinary Medicine, Oregon State University for providing the Internal Parasite photos.



PRE-PURCHASE EXAMS IN THE LLAMA

by Drs. Brad Smith and Pat Long College of Veterinary Medicine Oregon State University

During the past five years the cost of the average Llama has gone up dramatically, with top animals now commanding prices in excess of $100,000. When animals were relatively inexpensive the purchase of a medically unsound animal could be a trying and sad personal experience, but it was usually not a financial disaster if the animal died or had to be euthanized. Times have changed. With the increase in prices has come a slow recognition that while Llamas can be a great source of personal pleasures they are also a business, and that the loss of a key animal can severely affect the financial health of a farm. The pre-purchase exam is one tool available to the buyer to help ensure that he (she) is buying a healthy animal that is suitable for its intended purpose, be it breeding, show packing or a backyard companion animal. While a pre-purchase exam is No guarantee that an animal will exactly fit a buyer's needs, it does give the buyer a MUCH BETTER IDEA of what he (she) is buying.

This article will discuss what constitutes a pre-purchase exam, what information can be gained from the exam and what sort of expenses are involved. The article will also discuss the inherent limitations of the pre-purchase exam, and briefly explain how the information gained from an exam can be used in the selection of animals. But before the veterinarian is called in to do a pre-purchase exam, there are two questions that have to be answered by the potential buyer:

1) Is this the right type of animal for me?
2) Assuming the animal is medically sound, can 1 afford the animal?

The answer to the first question is easy for experienced owners. If they have been in the industry for some time, they know what type of animal they want – a gelding for a pack animal or perhaps a fancy female as a breeding animal. New owners should talk to more experienced owners and decide what their use for the animal will be. Buying the aggressive stud male as a young child's first 4-H project is not likely to work out well for anybody. The answer to the second question – price – is between you, your friendly local banker and the IRS. If you can't agree on a purchase price there is no point in spending money for an exam.

Picking a Veterinarian

Assuming the first questions are answered satisfactorily, it is time to arrange for a pre-purchase exam. It is the BUYER'S responsibility to both select and pay the veterinarian who will be going the examination. It is also desirable if at all possible, to pick a veterinarian who does not routinely do the veterinary work for the seller's farm, minimizing the potential for a conflict of interest. If the animals are being purchased out-of-state, the owners can help the buyer by suggesting the names of local veterinarians who work with Llamas. Although the buyer and seller may be best of friends, it is important to remember that the buying and selling of an animal is a business transaction and should be treated as such. Having the animal examined by a veterinarian is the best possible way to get an unbiased evaluation of the animal's health at the time of purchase.

Unfortunately, theory and reality sometimes clash and it may not always be possible to find more than one veterinarian in an area who has had adequate experience with Llamas to do a pre-purchase exam. Under these conditions it may be necessary to use the seller's regular veterinarian. When this is the case, the veterinarian is working for the buyer not the seller. When the veterinarian has finished the examination, the results will be given only to the buyer. If the buyer wishes to share them with the seller – great – but only at the buyer's discretion.

Examinations:

Once you have selected a veterinarian to do the pre-purchase exam, talk, to him (her) about your reasons for buying the animal. This will give the veterinarian an indication of how in-depth the examination should be. For example, if the animal is going to be used primarily as a breeding animal, an extensive examination of the reproductive tract will be done. This might include rectal palpation or measurement of blood progesterone concentrations for pregnancy determination. If the animal is a castrate who is going to be used as a pack animal, the veterinarian will do a less extensive examination of the reproductive tract. Also give the veterinarian any other information you might have about the animal before the exam – "The animal was bottle raised" – "He broke his leg two years ago" – or – "She aborted her last pregnancy." The extra information helps the veterinarian more fully evaluate the animal.

The examination will usually start with the veterinarian stepping back and looking at the animal. The veterinarian will be looking at general conformation, wool quality and getting a feel for the animal's general size, in particular asking, "For the animal's age, is it approximately the correct size and weight?" We have been seeing an increase in the number of animals that look reasonable at a distance but are simply too small for their age the 100# yearlings, etc. As the animal is being handled and walked around, the veterinarian also has an opportunity to get a feel for the animal's disposition, personality and to watch how it moves.

The Llama's legs will come in for careful examination, particularly those of young animals, Although being slightly knock-kneed is acceptable for youngsters, knees that are too close together can be indicative of nutritional, metabolic or possibly genetic problems Animals with severely deformed legs may require surgery (periosteal stripping) at a later age to straighten the legs. Although it is not a part of a routine pre-purchase examination, if significant leg abnormalities, are identified, the veterinarian may also recommend that a series of radiographs (X-rays) of the legs be taken. The veterinarian will want to watch the animal move for signs of lameness or other difficulties in motion. Other problems that can be detected include animals with dropped pasterns, problems with the stifle joint and signs of arthritis. The feet will be inspected for abscesses, sole erosions and nail problems.

Most veterinarians will run their hand down the neck and along the spine, looking for abnormalities and asses sing the animal's weight. Llamas in North America are frequently overweight, and feeling along the spine and down over the ribs gives a good indication of the animal's height. This is important since a moderate fat layer over the spine usually indicates a substantial amount of fat within the abdomen. The veterinarian will carefully check the wool, looking at its length, general condition and searching for external parasites. Common parasites should be treated and the animals rechecked before they are introduced into your herd. Although not routinely done as a part of a pre-purchase examination, a fecal sample can also be collected at the same time, and the animal checked for internal parasites.

The examination will also include an inspection of the nose looking for signs of nasal discharge, an indicator of a range of problems. The eyes will be inspected for cataracts, blindness, trauma to the eye and other related problems. The ears will be checked for infections or other problems. The teeth will be examined to verify the animal's age (if less than about five years old) and to determine if the fighting teeth have erupted and/or been cut off. Problems with dental malocclusion, difficulties with tooth eruptions and jaw abscesses can all be picked up during the exam. The animal's heart and lungs will also be listened to for detection of such problems as pneumonia and heart defects. Particularly with young animals, heart problems are not uncommon and can usually be detected by the veterinarian. If abnormal heart sounds are detected, an electrocardiogram may be recommended.

The veterinarian will inspect the animal's external genitalia. In the case of the female, the vulva and clitoris will be examined and abnormal size or shape noted. For the male, the testes will be palpated for size, shape and consistency. The penis will be examined if possible.

Blood Samples:

In the past, collection of blood samples for laboratory analysis, has not been a part of a routine pre-purchase exam. With the steadily increasing price of animals and the identification of a range of metabolic problems threat produce blood changes, a buyer should consider requesting a complete blood count (CBC) and a serum chemistry panel. The CBC includes a count of the number of red blood cells in the blood (RBC count) and the packed cell volume (PCV). A low PCV and RBC count indicate the animal is anemic. While anemia is not frequently observed in older animals, it is being seen more frequently in younger (1 year of age) animals. When the blood sample is collected, a smear is made, and the shape and size of the red blood cells are examined under the microscope. This can reveal a variety of potential problems. Another part of a CBC is a white blood cell (WBC) count. Abnormally high or low WBC counts are frequently an indicator of an infection or other serious problems. The differential count measures the relative percentage of the different types of WBC's. These percentages can provide additional useful information, such as an indication of heavy parasitism.

The chemistry panel measures enzymes and produces from specific organs. For example, several enzymes found in the blood are produced by the liver and an elevation of these parameters can provide useful information about liver damage due to a wide range of problems. Two other measurements, blood urea nitrogen (BUN) and creatinine concentration, provide information about kidney function. Creatinine kinase (CK), another enzyme, provides an indication of muscle breakdown. This can be important in areas of severe vitamin E/selenium deficiency. Some severely selenium-deficient animals in our area have had markedly altered CK concentrations. The other parameters measured in a chemistry panel all provide additional information about the function of organ systems. While none of these tests will guarantee that an organ system is functioning properly, abnormal values are a good indication that there are problems with the organ that should be investigated further.

Reproductive Exams:

The completeness of the reproductive tract exam depends on the intended use of the animal. A male purchased as a breeding animal should be particularly carefully examined. Although a record of being a successful breeder is an important indicator of the animal's potential, it is no guarantee that he is still fertile. If it is acceptable to the e buyer and seller, the best way to evaluate the male's potential as a breeding animal is to sedate the animal and then collect a semen sample by electro ejaculation. The risk to the animal is low, The sample can be evaluated for sperm concentration, shape of the sperm and an estimation of viability i.e. what percentage of the sperm is alive and forward moving. Electro ejaculation also permits a check for penile strictures, scars or other damage to the penis.

Reproductive exams of the female should include rectal palpation of the reproductive tract. This is usually possible in most females by 18 months of age. Good restraint is necessary for the safety of both the animal and veterinarian. Rectal palpation permits the veterinarian to access the condition of the cervix and uterus. If the animal has previously had a cria, the left horn of the uterus will usually feel larger than the right horn. Similarly if the animal is more than 30-45 days pregnant, the pregnancy can be confirmed. Rectal palpation also allows the veterinarian to determine if the reproductive tract is intact. The ovaries can sometimes be palpated for size, shape and consistency. Uterine infections can also be detected by palpation. If there are questions about the reproductive tract of the animal following rectal palpation, an ultrasound evaluation can be done at the same time. For sellers not comfortable with rectal palpations, pregnancy can be confirmed by collection of a blood sample for progesterone measurements. The range of options available for pregnancy determinations has been outlined in a previous article (Llamas, Vol.2, No.6, November/December 1988. p.25).

Reports:

At the end of the examination, the veterinarian will discuss his (her) findings with the buyer. This is the time for the buyer to ask other questions about the animal and to get a further explanation of findings, if necessary. In addition to discussing the results of the examination, the vet will give the buyer a written report of the examination. It is strictly the buyer's decision if he (she) wishes to discuss the report with the seller.

Expenses:

The cost of a pre-purchase exam will vary substantially according to what samples are collected, the tests ordered, the amount of professional time required for the examination and the geographical location. Due to the large number of variables involved, routine pre- purchase examinations can vary from less than $50 to more than $150. In addition to evaluating an animal's potential suitability, there are several other good reasons for doing a pre-purchase exam. If the animal is going to be insured, it is usually possible to do the insurance and pre-purchase exam together. When animals are going to be shipped across the state borders, federal laws require that the animal be examined by a licensed veterinarian and that a health certificate be prepared before the animal is sent. In addition to a physical exam, many states require that the animal be tested for tuberculosis and other diseases. These tests require several days for completion but can be started at the time of the pre-purchase exam. Finally, one of the other benefits of a pre-purchase exam for the new owner is a chance to meet your local veterinarian. Meeting your veterinarian while examining a new addition to your herd in infinitely more pleasant than meeting him (her) for the first time at 3:00 in the morning with a sick cria. The pre-purchase exam is also a good chance for the owner to talk to the veterinarian, discuss deworming and vaccination schedules and set up a preventive health program.

Conclusions:

It is vitally important to remember that a pre-purchase exam is NOT a guarantee that an animal is going to be problem free in the future. It is, however, a very useful tool to help buyers make an informed decision about the purchase of a new animal. A good pre-purchase exam will pick up most significant medical problems and will help buyers avoid serious and costly mistakes.

LLAMA NEONATAL CARE

by Drs. Brad Smith and Pam Reed, Oregon State University and Dr. Pat Long, Eastgate Veterinary Clinic, Corvallis, OR

The pending birth of a cria is a little like waiting for the arrival of your first child. You have been waiting for 9 or 11+ months, crossing your fingers and hoping that nothing will go wrong at the last minute. During the past 4 weeks, you have been watching the dam particularly carefully, have almost convinced yourself that she is in labor 2 or 3 times , and have been trying to guess what the cria will look like. You hope that the cria will have all the right parts hooked together correctly and working at birth. You want the dam to have an easy delivery, be a good milker, a great mom, and be rebred 2 weeks postpartum. Of course the cria will start breathing on its own, get up quickly start nursing shortly after birth and have no medical problems. In addition to being healthy, the cria will also be a cute female or a potential stud-quality male, nurse well and grow at a steady rate. Unfortunately, reality is frequently less ideal and a significant percentage of crias will have some problems during this period.

This transition is the most stressful and dangerous period in an animal's life. During this time (the periparturient period), the cria has to shift from being totally dependent on the dam for oxygen, nutrition and transportation to being largely selfsufficient. While the vast majority of Llamas are born without difficulty, some will have problems. This article will discuss preparation for birth, the normal process of parturition (birth), care and handling of the healthy neonate, and postpartum care of the dam. This article will not deal with the management of specific problems, rather it will present an approach to the handling and management of the healthy cria. Some of the more complex problems that can affect the newborn Llama (e.g. failure of passive antibody transfer, premature and dysmature crias, dystocias and inadequate milk production) will be discussed in subsequent articles.

Preparation for Birth

ENVIRONMENT: The choice of a birthing site depends largely on the time of year, farm facilities and the number of animals in the herd. If possible move the expectant mothers to a convenient pasture where they can be easily watched 4 to 6 weeks prior to birth. Housing the expectant mothers together is ideal. During cold or wet weather, the animals should also have access to a dry sheltered area protected from the wind, rain and snow. A sturdy barn with clean bedding is excellent. While hot weather is not usually as much of a problem for the cria, high temperatures can be hard on the dam during the last months of pregnancy. To the extent reasonably possible, stresses on the dam during the last months of pregnancy should also be minimized. These stresses would include long distance movement of animals, temperature extremes and dramatic changes in management practices.

VACCINATIONS: All vaccinations should be completed at least one month prior to birth. Irrespective of the area, at a minimum, all Llamas should be vaccinated for tetanus (tetanus toxoid) and given a seven-way Clostridium vaccine at least twice a year. The seven-way vaccine is immunizing the animal against Clostridium perfringens C, D, novyi, septicum, chauvoei and haemolyticum, all potentially serious pathogens in the Llama. In certain regions of the country, Leptos pira spp. can also be a serious problem, sometimes causing abortions. If this bacterial infection is a problem in your area, you may wish to discuss the possibility of vaccinating your animals against leptospirosis with your veterinarian. It has also been demonstrated that Llamas can be infected with the horse virus, equine rhinopneumonitis (EHV-l). While EHV-l infections can be a serious problem in the Llama, this infection appears to be rare and it is doubtful if vaccinating Llamas against EH V-l is justified except in unusual cases. In addition it is not known if the EHV-l vaccine is effective in the Llama and what potential problems might be involved with vaccinating large numbers of Llamas. Although it is very rare, Llamas can also be infected with rabies. If this is a concern in your area, you may want to consider vaccinating your animals (killed vaccine ONLY). If any of these diseases are of particular concern in your area(EHV-l, leptospirosis, rabies), discuss vaccinating your animals with your local veterinarian.

DEWORMING: Life vaccinations, deworming animals should be completed at least one month prior to birth. The choice of deworming agent will vary according to the time of year, the type and severity of the parasite burden in your herd and other considerations. While it is important to monitor and deworm Llamas in a regular basis, it is also important to remember that none of the widely used antihelmintics (e.g., Ivomec,TM Panacur,TM Strongid-T TM) are specifically approved for use in the Llama. While all of the above antihelmintics are generally recognized as being both safe and effective in the pregnant Llama if used at recommended dosages, in the very unlikely event that problems arise following dewormings, the manufacturers will usually not accept responsibility for problems, since their usage in the Llama is not specifically approved. The safety of the organophosphates (e.g. Teguvon TM) for the use of control of external parasites (lice) has not been established in the pregnant Llama and should be used in these animals only with great care. Its use should probably be avoided altogether in the Llama during the last trimester of pregnancy. No information is available concerning the safety of the anti-fluke drug chlorsulon (Curatrim TM) during pregnancy. If liver flukes are a problem in your herd, consult your veterinarian and discus your options with him/her. Untreated liver flukes can be fatal. (See Llamas July/August '89 issue).

FEEDING: Feeding of the Llama during the first two trimesters of pregnancy should be adjusted according to the animals condition (e.g. losing weight due to suckling etc). While a drastic weight-reduction program during pregnancy should be avoided, some weight loss in heavy animals is acceptable during this period. It is also important to avoid overfeeding animals during early pregnancy. This is particularly important for first time mothers. Work in other species has shown that excess fat is deposited in the mammary glands and can decrease the animal's ability to produce milk. It is interesting that even if the animal subsequently loses weight, much of the mammary fat deposits persist, and the animal's milk production never reaches its genetic potential. The same situation probably applies to the Llama. During the last 4 to 6 weeks pregnancy, it may be desirable to increase food availability and include some grain in the diet. It is NOT, however, necessary to dramatically increase food intake, and some Llama will not require any special feeding.

Parturition

The actual birth process (parturition) is divided into 3 phases with the highly original names of Stages I, II and III. During the preparatory Stage I labor, the uterus begins to contract and the cervix starts dilating. This stage usually lasts between 2 and 6 hours and is often not accompanied by obvious external signs. Some animals may show signs of discomfort (moving about, restlessly, repeatedly standing up and lying down) or may try to separate themselves from the rest of the herd.

Stage II of labor involves the actual expulsion of the fetus. During this stage, the fetus enters the birth canal. The uterus and abdomen contract (abdominal press) in a coordinated manner, and the fetus is forced out through the cervix and vagina. Seeing the water sac (amniotic membranes and fluids) is a good sign of imminent birth. The normal presentation of the cria will be with the forelimbs and head coming out first. Stage II labor in the Llama is rapid with the cria usually born within 2 hours. Most animals will be in Stage II labor for less than 30 minutes. Once the cria's head and feet are seen projecting from the vulva, birth should be completed within 30 minutes If the dam is not making steady progress in the expulsion of the fetus during this stage, assistance may be necessary. The management of delivery problems (dystocias) is a separate and important topic that will not be addressed in this article. Stage III of parturition involves the expulsion of the placenta. Unlike some species, e.g., the COW, retention of the fetal membranes (retained placenta) is a relatively rare occurrence in the Llama. The placenta will usually be expelled within 4 to 6 hours following parturition. If you are not sure that the placenta has been passed within 24 hours following birth, contact your local veterinarian. Don't pull on the placental tissues you may see protruding from the vulva.

Postpartum Period – Immediate Considerations

RESPIRATION: The most immediate concern in the handling of a neonate is to make sure the animal is breathing. Clear membranes and mucus away from the mouth and nostrils by hand or with a towel. Some owners use a bulb springe, if necessary, to help clear the nostrils. If the cria is not breathing, rubbing the head, tickling the nose with a piece of straw, or pouring a small amount of cold water over the cria head have all been reported to help stimulate respiratory system of excess fluids and mucus. Carefully lifting and supporting the cria (especially the neck!) in a similar manner has been reported to work in the Llama as well. Artificial respiration can be started, if necessary, by placing a tube in one of the cria's nostrils, wrapping a hand around the nose to occlude the other nostril, and the gently blowing. Alternately, mouth-to-mouth resuscitation can be used. With either method, blow only hard enough to fully expand the chest, remove your mouth and then let the chest deflate. Continue resuscitation until the animal starts breathing on its own or the heart stops beating. Repeat this sequence 8 to 10 times per minute, Be careful not to over inflate the cria's lungs.

ABNORMALITIES: The major abnormalities that you need to be aware of are heart defects and choanal atresia. The Llama is an obligate nasal breather and animals with choanal atresia are partially or totally unable to breath through their nose. These animals frequently have difficulty breathing even when the membranes and mucus have been cleared. The breathing will usually be noisy and labored, and the animals may gasp for breath following even mild exertion. The problem is even more pronounced when the animals attempt to nurse. This is a problem that needs immediate attention by your veterinarian because the crias may inhale milk while nursing, develop a case of pneumonia and frequently die as a result. Cardinal signs of heart defects include pale gums and heart murmurs. Most animals with clinically significant cardiac defects have very pronounced changes in the heart sounds that can be detected with a stethescope placed over the heart. These problems require prompt professional help.

Postpartum Period

Once the cria has been delivered and is breathing normally, the next step is to make a quick evaluation of the animal's condition. Under ideal circumstances, the cria will stand 2 hours of birth, be observed to nurse within 4 hours of birth, weigh over 20#s and have at least 4 incisor teeth through the gum line. The cria will also have erect ears, a rectal temperature between 100 and 102 F (33.7 38.9c), be breathing normally, and show no signs of straining or other medical problems. These conditions are summarized in Figure 1. If the cria is normal, the next step is well-baby care.

NAVEL: Under most conditions, relatively little blood will be lost from the umbilical cord during birth. If the cria is, however, losing blood from the cord, tie the cord off with a piece of string soaked in betadine, leaving a stump about 1 inch long. Under any circumstance, the navel should be dipped in either 7% tincture of iodine or a "tamed" iodine solution (e.g. Betadine TM). The 7% iodine is probably a better choice since it dries rapidly and more completely than the betadine. The cord should be dipped 3 times during the first 8 hours. Dipping the umbilical cord into a 35mm film can containing the iodine works well. Although a spray bottle is a bit neater, it doesn't coat the navel as well. Both the 7% iodine and the betadine stain everything quite nicely and should be used carefully. The first dipping of the navel should be done as soon as possible after birth to help prevent it from becoming infected with a wide range of common bacteria. Navel infections can be severe and life threatening.

STANDING: Most crias will stand unassisted within 15 to 60 minutes after birth. If the cria has not stood within 2 hours, you will need to closely inspect and check the animal for limb or other problems. Most crias will have a harder time standing on a smooth floor than on dirt, grass or bedding.

NURSING: Once the navel has been dipped and the cria is standing, the next important step is to make sure that the animal is observed to nurse. Nursing during the first 24 hours of life is particularly important since it is during this time that the cria will be absorbing colostrum, the antibody rich fraction of milk that will provide most of the cria's immunity during the first few weeks of life. Since the immune system of the Llama (as well as essentially all other mammals) has not been exposed to bacteria and viruses at birth, the animal's immune system is not producing antibodies prior to parturition. Until the immune system of the cria really becomes functional (at 1 to 2 months of age,) the cria is dependent on the antibodies absorbed from the dam to protect it from a wide range of pathogens.

Due to the nature of the Llama placenta, essentially no immunoglobulins (antibodies) are transported from the circulatory system of the dam to the neonate before birth. As a result, the cria is totally dependent on getting colostrum for adequate antibody protection. Another interesting characteristic of the Llama intestinal tract (as well as other animals) is that they are able to absorb significant amounts of this antibody rich fraction of milk only during the first 24 hours of life. After this period, the antibodies in the milk are digested by the cria's intestines.

Due to the importance of the cria getting colostrum, watch to see that the cria nurses within the first 2 hours postpartum. You want to see the cria nurse several times within the first 12 hours of life. Although some colostrum can be absorbed up to 24 hours postpartum, the best absorption occurs within the first 12 hours of life. Don't worry about the cria getting "too much" colostrum.

ENEMAS: There is no consensus as to the need for enemas in the newborn animal. The function of the enema is to loosen the fecal material formed prior to birth (meconium) and encourage the animal to defecate. If the meconium is not removed, it can block the intestines producing problems. If the cria has been observed to defecate shortly after birth (typically a 3 to 4 inch long stool), no enema is required. It is, however, important to differentiate meconium (darkcolored) from the lighter-colored feces produced following nursing. If no meconium is observed, an enema should be used. Once the meconium has been passed, the animal will usually defecate normally thereafter. The DOSS enemas work well and can typically be purchased from farm-supply stores and your veterinarian. To use the enema, the tip of the tube should be carefully inserted into the rectum and the plunger depressed. The typical volume is 10-12 ml. A similar volume of dilute, soapy-water enema also works well. A 12 ml syringe can be used to a administer the enema. Be sure to use a very dilute solution of mild hand or dishwashing soap.

WEIGHT AND IDENTIFICATION: The newborn cria should be identified and records started for the animal shortly after birth. Identification can include a written description of the animal's markings, ear tags or tattoos. Particularly with large groups of animals, photographs are also very useful. Although rarely a problem, crias will occasionally get separated from the dam and wander off. Positive identification of the cria easier as well as facilitate record keeping later in the animal's life.

Most crias weight between 20 and 30 pounds (9-14 kg) at birth. While heavier crias are being reported, there is a concurrent increase in the percentage of dystocias as birth weight increases. At the other extreme, animals weighing less than 20# also deserve special attention. These underweight animals are frequently premature or dysmature and often have special problems that will be discussed in another article.

Getting an accurate weight on the cria is important and although a bathroom scale will work in a pinch, most of them are not particularly accurate or reproducible. A small baby scale or produce scale with a range of up to 50 pounds is ideal. Scales can be purchased at farm supply stores or via mail order (e.g., Nasco). The cria should normally be weighed within the first 2-3 hours after birth. Following a cria's weight is one of the best means of assessing the animal's health, and the initial weight will provide a frame of reference to check on the cria's development.

Host crias will start gaining weight rapidly following birth and should gain between 0.5 and 1.0 pounds per day for the first month of life. Normal animals will approximately double their birth weight within the first month of life. First-time (primiparous) mothers are sometimes a little slower than more experienced (multiparous) mothers in reaching their full lactation potential. In these animals, milk production may be low for the first 1 to 2 days, and the cria may not start gaining weight for the first 2-3 days. WATCH THESE ANIMALS CAREFULLY AND MAKE SURE THAT THE CRIA IS NOT LOSING WEIGHT.

A good rule of thumb is to weigh the cria twice during the first 24 hours postpartum and then daily at the same time each day for at least the next 7 days. If possible, continue weighing the animal on a daily basis for the first two weeks of life. After the first 4 to 6 weeks of life, the cria's rate of gain may become less steady. Animals may not gain weight for a week or so and then have a growth spurt.

TEMPERATURE REGULATION: Although the cria is a relatively hardy creature, it does have a large amount of surface area relative to its body mass and has a tendency to lose heat. This is especially true immediately postpartum then the cria is wet. Drying the cria with a bath towel will substantially cut down on its heat loss. Animals that are born in exposed or wet conditions have the potential for becoming hypothermic. Severely hypothermic animals may have rectal temperatures that fall below 90F and many will die. Special attention should be paid to thermoregulation (temperature regulation) in premature or dysmature animals. These animals frequently have problems maintaining body heat and may require supplemental warming.

If the cria appears alert, taking its temperature is unnecessary. If, however, the animal has been outside seems depressed or feels cold to the touch lubricate the tip of a thermometer with a small amount of lubricant (e.g. KY Jelly) and take the animal's rectal temperature. Formal temperature for a cria is usually between 100 and 102F (97.7- 98.8C) There is usually no problem if the temperature is slightly low (down to 93 or 99F). If the thermometer reads less than 98F, however, start by shaking down the thermometer retaking the animal's temperature and making sure the thermometer was in the animal long enough. If the temperature is still below 98F, the animal may need to be warmed, and it is suggested that you contact your local veterinarian since the animal may have other problems. If you are warming the animals, make sure, however, you don't OVERHEAT and burn the animal. This is surprisingly easy to do with heating pads turned up too high or heat lamps too close to the animal.

Vitamin E/selenium. The need for extra vitamin E and selenium varies widely with the time of the year, pasture conditions and area. In selenium deficient areas, administration of 1 ml of Bo-Se (Schering) as an intramuscular (im) injection into the rear leg is usually adequate. If you have not given im injections before, you may want to have your veterinarian assist you the first time. There is a major nerve in the hind limb (ischiatic nerve) that can be damaged if hit with the tip of a needle.

Care of the Dam

With all the excitement that is normally focused on the new cria, the dam is frequently forgotten in the process and not given adequate attention. Unless the delivery has been extremely difficult, examination of the dam can usually wait until after the cria is on its feet and starting to nurse, Once the cria is off to a good start, however, the dam should be carefully examined.

PLACENTA: The placenta will usually be delivered within 4 to 6 hours postpartum. If the placenta is protruding from the vulva, don't pull on it. The fetal and maternal tissues will usually separate within a few hours postpartum, and the placenta will be expelled on its own. Vigorous pulling on the placenta can damage the uterus. Once the placenta has been delivered, a good practice is to spread the placenta out on the ground and check to make sure that none of it has been left in the dam. It is also suggested that gloves be used when handling the placenta on the slight chance that it is contaminated with certain pathogenic bacteria. Gloves should ALWAYS be used when handling aborted fetuses and membranes. The careful disposal of aborted tissues, away from other wild and domestic animals, is imported to prevent the spread of possible diseases. You may wish to give the aborted tissues to your veterinarian for further examination. Unfortunately, the placental tissues degenerate rapidly so setting the material to your veterinarian rapidly is important.

TRAUMA: Check the vulva and surrounding region to confirm that the tissue didn't rip during the birth process. If the tissue has been torn, it may be necessary to clean and surgically repair the tear. Since it is much easier and usually more effective to treat tissue damage shortly after birth than to wait several days, the dam should be examined within the first 12 hours postpartum. Occasionally a Llama may also prolapse (evert) her uterus. If either of these situations has occurred, assistance from your veterinarian will normally be required to clean the uterus, get it back into the animal, and prevent it (sometimes) from prolapsing or to repair any tears.

MILK PRODUCTION: To help ensure that the cria is able to get milk, run your hand under the dam's belly and gently squeeze each of the teats. You should be able to get a drop or two of milk from each teat. This has the function of clearing debris, ensuring that each quarter of the mammary glands is functional. Some animals will have waxy plugs in the teats preventing normal milk release. Although relatively rare in the Llama, a few animals will occasionally get a mammary infection (mastitis). The mammary glands in these animals will frequently feel unusually warm, firmer than normal and be distinctly reddened. If you suspect that the animal has mastitis, contact your local veterinarian.

NUTRITION: The postpartum dam should be continued on the higher plane of nutrition to ensure adequate milk production. Unfortunately, it is difficult to make firm recommendations on feeding the postpartum dam since the nutritional demands for these animals are not well-established. Assuming that the metabolic requirements of the lactating Llama are similar to those of other lactating ruminants, both the energy content and the percentage of protein in the diet should be increased for the first 1-2 months of lactation. Shifting the animal to a diet containing some alfalfa and grain is usually adequate. How much to feed the dam largely depends on farm-management practices and the animal's condition. Adjust the animal's food intake (if possible) to keep the dam at an optimum weight. When adjusting diets, however, sudden changes in feed type should be avoided. If possible, slowly change diets over a 1-2 weeks period.

Summary

Preparation for birth should include

1) bringing vaccinations and dewormings up to date,

2) moving the dam to a location where she can be watched and

3) somewhat increasing her food intake, if necessary, based on her body condition. Stress due to heat, moving and social changes during the last 4-6 weeks of pregnancy should be minimized. The first

concern following birth is to ensure that the cria is breathing. Once the cria is breathing normally, it should be given a careful evaluation, the navel dipped in iodine, the animal weighed, identified, and helped to stand, if necessary. Nursing should be observed within the first 24 hours of life. The dam should be checked for lacerations or damage to the reproductive tract. The placenta should be expelled and checked within the first 6 hours postpartum and the mammary glands palpated to clear blockages in the teat canals and ensure function.

TABLE OF CONTENTS

Function of the manual:

This manual was written with the intent of being used in conjunction with the Oregon State University, College of Veterinary Medicine, Llama Neonatal Care Seminar. The material is primarily presented in an outline form and organized, hopefully in such a manner that owners will be able to use it as a reference manual.

This course does NOT deal extensively with dystocias (problem birth) The topic of dystocias is a complex subject that is beyond the scope of the material being covered it this seminar. The focus of this seminar will be on the normal changes and processes associated with conception, pregnancy, birth and the postpartum period.

Acknowledgements: We wish to thank Drs. Timm and Moos for their assistance in preparing this manual.

1) Anatomy and Physiology of Pregnancy

a) Normal Female Anatomy

Ovaries:

- See Figures 1.1 – 1.3
- Function:
  a) Mature eggs containing half the genetic material of the developing foetus are released from follicles on the surface of the ovary.
  b) Corpus luteum – formed after egg has ovulated and is the primary source of the hormone progesterone.
- Animal can ovulate from either ovary.
- Puberty is defined as the start of ovarian activity. Puberty usually occurs between 1 and 2 years of age although some animals will reach puberty at an earlier age.

Oviduct (uterine tube):

- See Figures 1.2 and 1.3
- Function:
  a) Transport egg from the surface of the ovary to the uterus.
  b) Fertilization occurs at about the midpoint of the oviduct.
- Although the egg will be fertilized within a few hours following breeding, based on work in other species, the fertilized egg will probably remain in the oviduct for several days before it is transported to the uterus.

Uterus:

- Site of fetal development.
- Following fertilization, the egg divides until it forms a small, solid structure called the MORULA.
- At some point following fertilization, the morula changes into a BLASTOCYST (a ball of cells with a hollow Centre) and attaches (implants) to the wall of the uterus.
- The timing, of implantation is unknown in the llama.
- Due to the similarity of the placentas found in the llama and the horse and pig, it is assumed that implantation probably occurs several weeks following fertilization as it does in the horse and pig.
- The site of blastocyst attachment will develop a placenta.

The placenta is comprised of both maternal and fetal tissues. Placental function is discussed in Section 1.C.

Cervix:

- A tight ring of muscular tissue separating, the uterus and vagina. (The cervix is technically a part of the uterus.) When the animal is open (non-pregnant), the cervix will be open permitting the passage of sperm from the vagina into the uterus.
- Once conception has occurred, the cervix closes and the pregnancy will continue ONLY if the cervix stays closed.
- Animals with significant damage to the cervix will have greater difficulties in carrying a pregnancy to full term.

Vagina:

- Muscular tissue connecting cervix with vulva.
- Probable site of semen (sperm mixed with other secretions from the male) deposition.
- Common site of injury during difficult births.

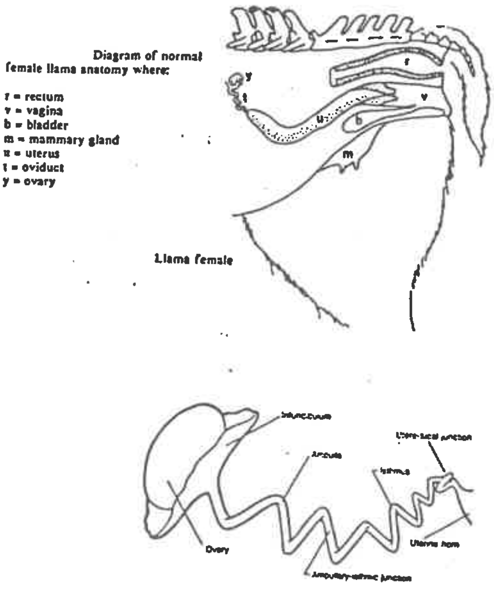
Vulva:

- External opening of the vagina.
- Located just below the anus.

b) Physiology of the Normal and Pregnant Female:

- The llama is considered to be an INDUCED OVULATOR. Other induced ovulators include the cat, rabbit, ferret, mink, and otter.
- Unless the animal is pregnant, the normal female llama will usually be receptive to breeding by the male.
- The breeding stimulus causes the release of LUTEINIZING HORMONE (LH). The penis stimulating the face of the cervix is probably the primary stimulus causing the release of LH from the anterior pituitary, a small gland located at the base of the brain.
- The LH causes a mature FOLLICLE on the ovary to rupture, releasing the egg.
- hCG (human chorionic gonadotrophin) has LH-like activity. If admin-

Figure 1.1 Cross sectional diagram of the reproductive anatomy of the female llama.



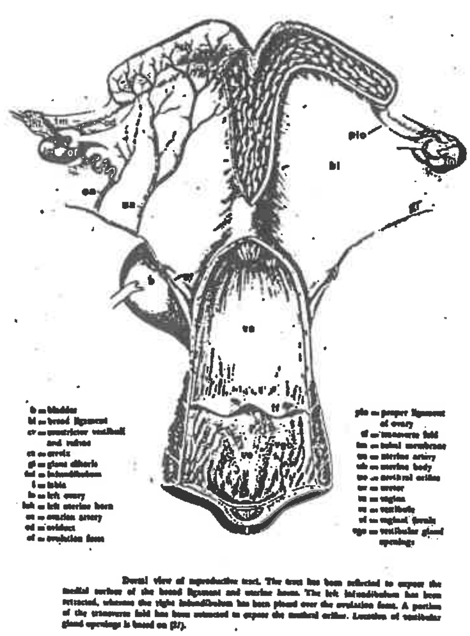


Figure 1.2 Dorsal (looking down) view of the reproductive tract of the mare. The reproductive tract of the llama is very similar to that of the mare.

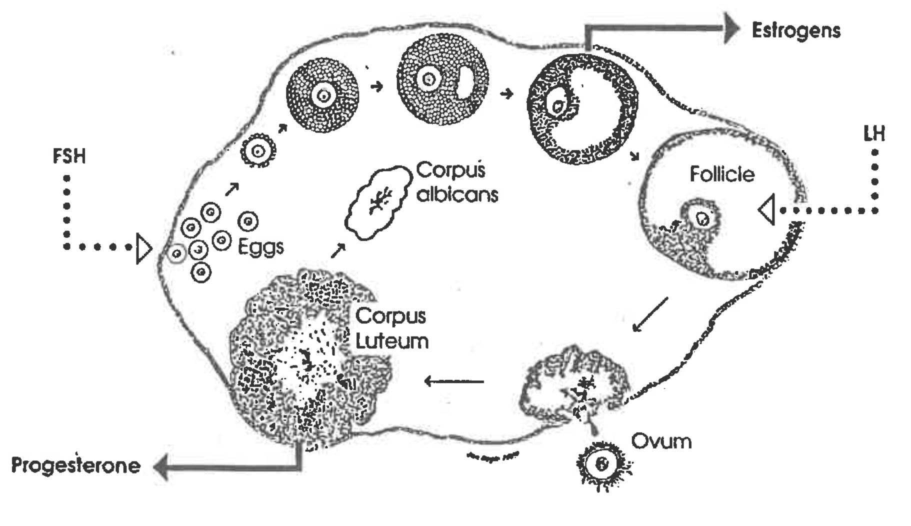


Figure 1.3 Diagrammatic representation of a typical mammalian ovary.

istered at appropriate dosages, it can function like LH and induce the rupture and ovulation of a mature follicle.
– The oviduct picks up the egg as it is released from the surface of the ovary.
– Following conception, the fertilized egg remains in oviduct for a few days prior to being transported into the uterus. If the fertilized egg were to implant in the oviduct, the condition would be termed a TUBAL PREGNANCY, a potentially life-threatening problem in the human.
Tubal pregnancies have not been identified in the Llama.

Pregnancy Diagnosis:

See article in appendix (Section 8E)

i) Male
– Easiest, cheapest and one of the most effective methods of pregnancy detection.

ii) Blood Progesterone
– Measures progesterone being produced by the corpus luteum (CL). Reasonably accurate, moderate cost. A few false positives. Blood progesterone concentrations of> 1.5 ng/ml indicate pregnancy if the timing of sample collection is correct.
– See Figure 1.4

iii) Rectal Palpation
– Accurate, inexpensive, some discomfort to animal, potential for rectal tears.

iv) Ultrasound
– Accurate, requires skilled operator, moderately expensive. Can be done either with the probe held in the flank region (not particularly effective) or when the probe is inserted into the rectum, (good accuracy). Potential for rectal tears if done rectally.

c) Placenta – Anatomy

Types:

a) hemochorial – human
b) endothelialchorial – dog and cat
c) syndesmochorial – cow, goat
d) epitheliochorial – horse, pig, Llama

Placental types – differences in

a) size
b) shape
c) number of layers between fetal and maternal blood supplies.

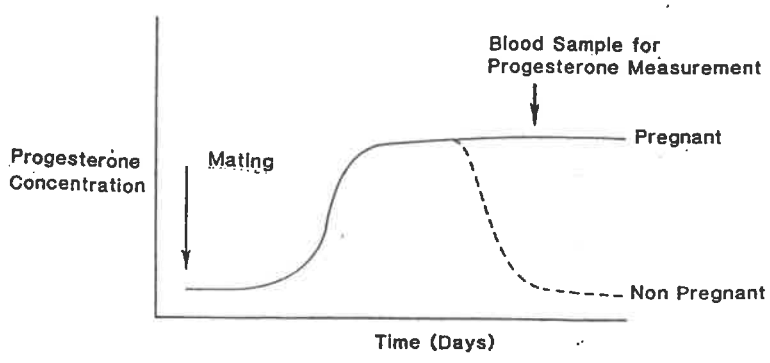


Figure 1.4 Schematic representation of the serum progesterone concentrations in a llama following a single breeding. If the animal does not become pregnant, the progesterone concentrations will begin to decline within 12 - 14 days following breeding.

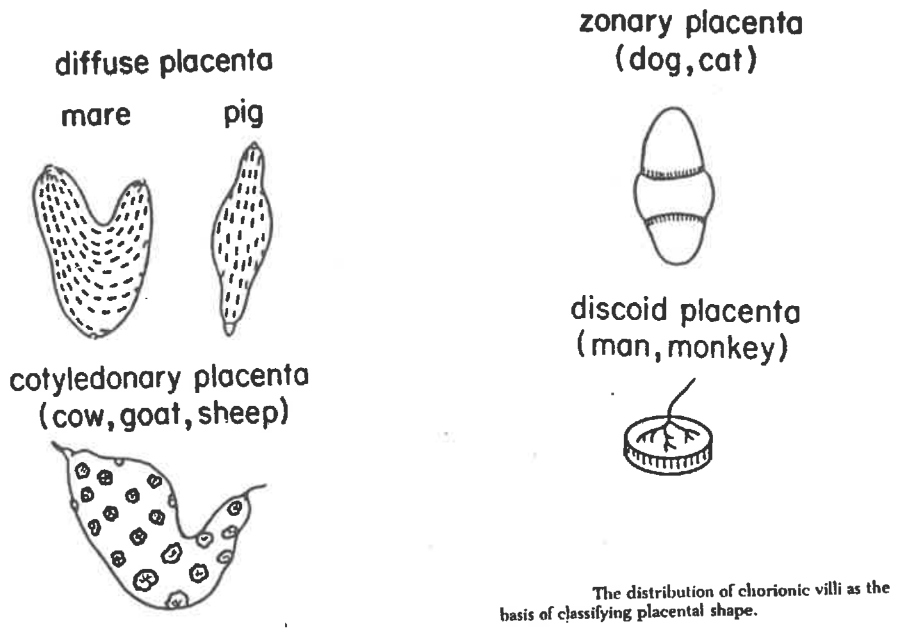


Figure 1.5. Examples of some of the placental types encountered in a wide range of species. The llama is similar to the mare and pig in having a diffuse-type placenta.

Table 1.1
INCREASE OF THE WEIGHT OF THE FOETUS AFTER SIX MONTHS ANI DURING THE FINAL THIRD STAGE OF PREGNANCY

Weight of the fetus of S. American Alpaca				
At 6 months (180 days) gr.	Increase of weight, up to date of birth %	Weight at 2/3 pregnancy (230 days) gr.	Increase in weight final third stage of pregnancy %	Weight at birth (345 days) gr.
600	93.34	2,500	72.23	9,000

Concept:

a) As the number of layers separating the maternal and fetal blood supplies increases, the importance of COLOSTRUM increases proportionately. (Topic discussed in section 5.D)
b) The greater the number of layers, the larger the placenta, in relationship to uterine size.

Llama:

a) Has a placenta that entirely fills the uterus and the cria has an absolute requirement for colostrum.
b) Although the placenta fills both horns of the uterus, the foetus is ALMOST ALWAYS (> 95% of all pregnancies) carried in the left horn of the uterus.

Placenta – Physiology:

Nutrition:

The placenta is the sole route by which nutrition is transferred from the dam to the developing foetus.

Respiration:

The placenta allows oxygen to diffuse from the maternal circulatory system through the placenta to the foetus. As the oxygen is used, the foetus produces carbon dioxide (CO) which diffuses from the foetus, through the placenta, to the maternal circulation and is expelled from the dam's lungs.

Hormone production:

Hormone production by the placenta is intimately involved in the regulation of the birth process. Hormones produced by the foetus and the placenta are involved in initiating the process of parturition (birth).

Antibody transfer:

In those species in which there are fewer layers separating the fetal and maternal blood supplies, antibody transfer is relatively less important. In species with relatively few placental layers, e.g., the human, mouse and monkey, colostrum

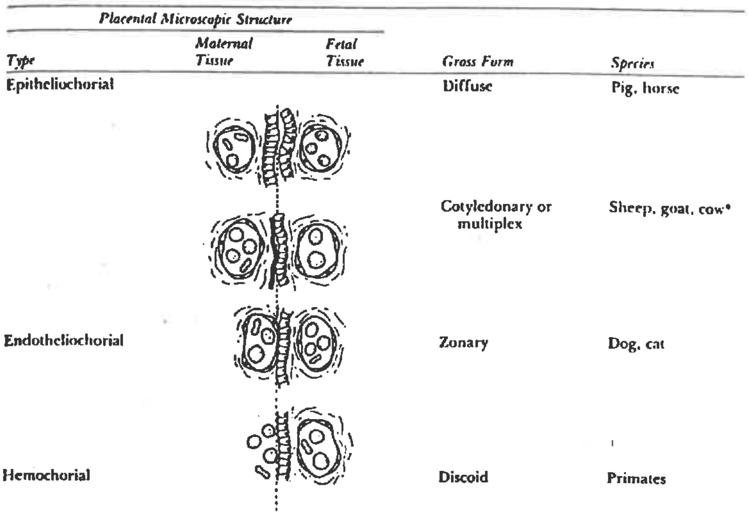
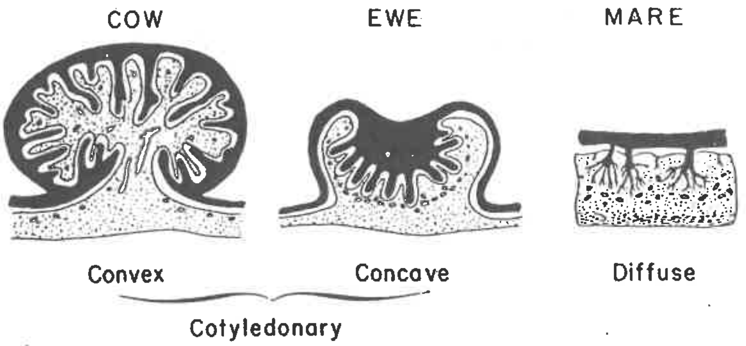
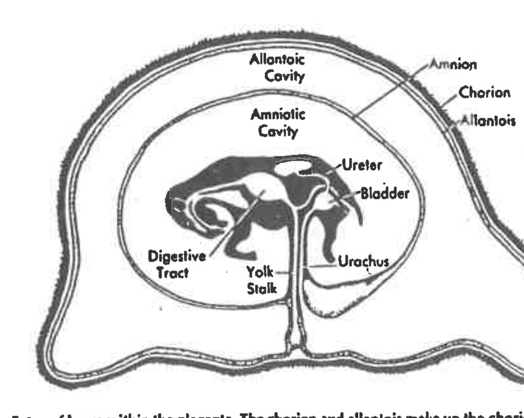


Figure 1.6. Histologic classification of the different placental types.



Epitheliochorial placenta of cow (left), ewe (middle) and mare (right). Villi from chorioallantois (black) invade crypts in maternal uterine epithelium (stippled). The apposition of maternal and fetal tissues is diffuse (mare) or localized as placentomes (cow and ewe). Each placentome is composed of fetal cotyledon and maternal caruncle. (Adapted from Mossman, 1937.) (From Hafez, E.S.E.: Reproduction in Farm Animals. ed. 4. Philadelphia, Lea & Febiger, 1980.)

Figure 1.7 Diagram comparing the placentas found in the cow, sheep and mare. The placental type in the llama is very similar to that found in the mare.



Fetus of horse within the placenta. The chorion and allantois make up the chorioallantois, often called the chorion. (After Witschi, Development of Vertebrates, W.B. Saunders Co.)

Figure 1.8 Diagrammatic representation of the fetal membranes.

is not nearlyas important as in the horse, pig, and Llama.

d) Other Fetal Tissues:

Amniotic sac:
Hippomanes:

e) Weight:

– See Table 1.1.
– Weight, gain during first 2/3 of pregnancy should be relatively insignificant.
– Unlikely to see weight gain until latter 1/3 of pregnancy or the last 1-2 months.

2) Preparation for Parturition (Birthing):

a) Environment:

– The South American Camelidae family (Llama, alpaca, guanaco, and vicunae) evolved in the harsh Andean environment and are relatively tolerant of temperature extremes (particularly cold).
– Even Though relatively well-adapted to the environmental extremes, a moderately high neonatal loss is considered acceptable in South America.
– Producers in North America are interested in minimizing the neonatal losses.

– Objectives:

i) Clean dry environment for parturition. Clean straw makes good bedding.
ii) Avoid temperature extremes. If cold wet weather, move animal to clean, dry barn. Warm weather – pasture birthing is fine.
iii) Avoid chilling of cria if possible. Animal has relatively little body mass and a large surface area. Will tend to lose heat and become HYPOTHERMIC (decreased body temperature). Protection from the wind is particularly important.

– High Temperatures:

– Can represent a major problem for the dam. Problem is particularly significant for heavy-wooled and overweight animals. Animals may become HYPERTHERMIC (elevated body temperature) and show signs of heat stress.
– Consider shearing and/or providing shade for animals.
– Comfort index – has been empirically developed for the Llama.
It can be used as a starting point for evaluating the potential for heat stress.
Temperature (F) + Relative Humidity (%) = Index

Index	Condition
> 120	No problem
> 120 – 180	Possible problems
> 180	Heat stress likely

– Although crias will normally get sufficient liquid from the dam, in high temperatures with or without high humidity, the animals may dehydrate significantly.

b) Vaccinations and Dewormings:

Vaccinations:

– Have all vaccinations completed no lessthan 1 month prior to parturition.

– Choice of vaccinations needs to be partially based on the diseases problems in your area.

– All animals should receive the 7-way Clostridial vaccines (Clostridium perfringens C and D, novyi, septicum, chauvoei, haemolyticum) and Clostridium tetani (tetanus toxoid).

– Vaccinations for leptospirosis, equine rhinopneumonitis, (EHVI) and rabies should be based on the prevalence of the problem in your area. Consult your veterinarian before using these vaccines. If rabies is a significant problem in your area, USE ONLY THE KILLED FORM OF THE VACCINE.

– Most vaccines will be given intramuscular (IM) or subcutaneously (SQ). Follow the specific recommendations provided by each manufacture. As a general guide, the sheep dosages can be used. It is important to remember, however, that none of the vaccines have been approved for specific use in the Llama.

– Several good sites for vaccinating animals include:

– a) the lightly-haired area on the back of the rear legs (SQ, IM)

– b) chest wall behind elbow (SQ)

– c) front of chest (IM, SQ).

– Most vaccines can be given with a 22 gauge needle and a 3 or 6 ml syringe. With all vaccinations, there is always the possibility of abscesses forming at the injection site.

Deworming:

– Worming requirements will vary significantly between farms depending on the season, stocking density, frequency of pasture rotation, and other factors.

– Before deworming your animals, do a fecal floatation test and determine what type of worms are present and make an estimation of the degree of parasitism. Your local vet can help either with running the fecal test or selecting the appropriate drugs.

– At present there are NO deworming agents specifically approved for use in the Llama. No carefully controlled clinical studies have been conducted evaluating the safety and efficiency of the various deworming agents in this species. If adverse reactions occur, the drug company will accept no responsibility for problems since the drug is being used in an EXTRALABEL manner.

– Clinical experience has indicated that ivermectin (IvomecTM), fenbendazole (PanacurTM), and pyrantel pamoate (StrongidTM) all appear to be safe and effective in the Llama. There is less information available concerning the use of these drugs in pregnant animals although they should be safe. Work in other species suggests that they should be safe in the Llama.

– The organophosphates (e.g., TeguvonTM – used for external parasite control) shouldbe avoided in the late pregnant llama.

– No information is available concerning the safety of the anti- fluke drug chlorsolon (CuratremTM) or the coccidiostats such as amprolium (Corid TM) or Deccox – TM.

– Concepts:

a) Have all drug treatments for both internal and external parasites completed at least 1 month prior the expected date of parturition.

b) Determine if you have a parasite problem before you treat.

c) DON'T use organophosphates during late pregnancy.

c) Feeding:

– No adjustment in feed intake is required during the first 2/3 of pregnancy. Most animals in North America could stand to lose a substantial amount of weight. While a drastic weight-reduction program should be avoided, some weight loss in very-heavy animals is acceptable during this period.

– Avoid overfeeding animals during early pregnancy. This is particularly important for first-time mothers. Work in other species has shown that excess fat is deposited in the mammary glands and decreases the animal's ability to produce milk. Fat animals also appear to have mole problems with rebreeding.

– Llamas will eat between 1.5 and 2.0% of their body weight per day.

– Last trimester:

– slowly increase the % protein in the feed

– increase the caloric density of the feed

– The nutrient requirements of the Llama have not been adequately established.

– Concept:

Adjust feed to maintain appropriate body condition.

d) Stress:

– MINIMIZE

– Avoid, if possible:

a) transporting animals – particularly during that last month of pregnancy

b) environmental stresses – especially temperature extremes. This can be minimized by breeding animals so that parturition occurs during the spring and fall.

3) Parturition:

Concept:

The greatest potential danger to a cria is during the transition from the uterine to the external environment.

a) Initiation

– The assumption is that concepts developed in other species are applicable to the Llama. The exact stimulus leading to initiation of parturition (birthing) is not, however known. The approximate timing of parturition is likely related to fetal size.

– See Figure 3.1.

– In cattle and sheep, the fetal brain stimulates adrenal glands to produce glucocorticoids (e.g., cortisol) leading to decrease in progesterone and increased estrogen concentrations. Maternal prostaglandins, glucocorticoids, and oxytocin are involved in parturition. A similar sequence of events are likely occurring in the Llama.

Concept: DO NOT USE PROSTAGLANDINS (E.G., LUTALYSETM, ESTRUMATETM), OXYTOCIN OR GLUCOCORTICOIDS (E.G., DEXAMETHASONE, CORTISONE) IN THE PREGNANT ANIMAL – MAY INDUCE PREMATURE PARTURITION.

FETAL REGULATION OF PARTURITION

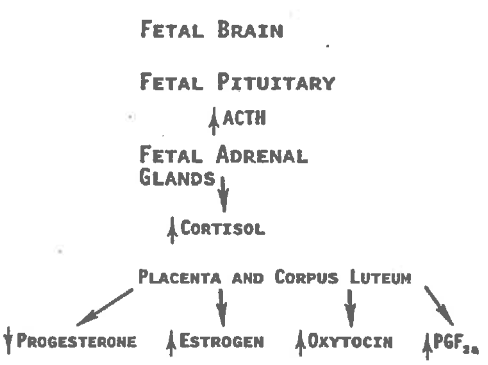


Figure 3.1 Endocrine changes associated with the initiation of parturition. These changes have been established for some species. It is not known if similar changes apply to the Llama.

b) Stages of Labor

Stage I – Preparatory Phase

– During, the first stage the uterus begins to contract and the cervix dilates. This stage usually takes between 2 and 6 hours. Stage I labor in the Llama is normally not dramatic, with many animals not showing any obvious signals. Some animals may show some signs of discomfort (moving about restlessly, standing up and laying down repeatedly) or may try to separate themselves from the rest of the herd. A high percentage of the births will occur during the day.

Stage II – Fetal Expulsion

– Stage II of labor involves the actual expulsion of the fetus. During this stage the fetus enters the birth canal. The uterus and abdomen contract (abdominal press) in a coordinated manner, and the fetus is forced out though the cervix and vagina. Seeing the water sac (amniotic membranes and fluids) is a good sign of imminent birth. The Normal preservation will be with the forelimbs and head coming out first. Stage II labor in the Llama is rapid with the cria usually born within 2 hours. Most animals will be in stage II labor for less than 30 minutes . Once the fetal head a feet are seen projecting from the vulva, birth should be completed within 30 minutes. If the dam is not making steady progress in expulsion of the fetus, help may be necessary.

Stage III – Placental Expulsion

– Stage III involves the expulsion of the placenta. Unlike some species, e.g., the cow, retention of the fetal tissues (RETAINED PLACENTA) is a relatively rare occurrence in the Llama. The placenta will usually be expelled within 4 to 6 hoursfollowing parturition. If you are sure that the placenta has not been passed within 24 hours following birth, contact your local veterinarian. Don't pull on the placental tissues you may see hanging from the vulva.

– Don't pull on the placenta. It will be expelled by the dam.

– When the placenta has been passed, spread it out on the floor and check to see if any large sections are missing. It should be possible to clearly see how the placenta filled both horns of the uterus. **Gloves should be worn when handling the placenta.**

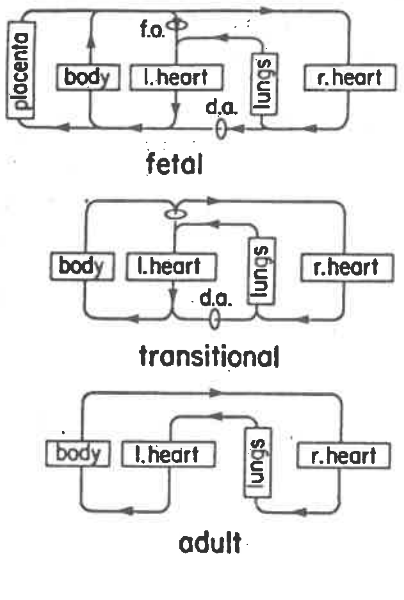
Problems:

Be suspicious of a dystocia (problem birthing) if:

a) The dam has been in first stage labor longer than to 6 hours without signs of progress (e.g., vaginal discharge or straining).

b) The amniotic sac (water sac) is observed and delivery is not completed within the next 2 hours.

c) Birth has not occurred by 6.00 PM



Diagrams illustrating the changes in fetal circulation at birth. In the fetus both ventricles work in parallel. At birth the placental circulation ceases and the foramen ovale closes (*f.o.*) to give rise to the neonatal (transitional) circulation. During the next few days the lungs become fully functional and the ductus arteriosus (*d.a.*) closes to produce the adult circulation. (After Born, Dawes, Mott, and Widdicombe, 1954. Cold Spring Harb. Symp. Quant. Biol. 19, 102.)

Figure 5.1.

Changes in the circulatory system of the fetus and the neonatal cria.

4) Postpartum Period – Immediate Considerations:

a) Respiration

– Clear membranes and mucus away from the mouth and nostrils. Use a bulb syringe, if necessary, to clear the nostrils. If the cria is not breathing, rubbing the head, tickling the nose with a piece of straw, or pouring a small amount of cold water over its head have all been reported to stimulate respiration. Lifting calves and lambs up by their hind legs works well to help clear the respiratory system. Carefully lifting and supporting the cria in a similar manner has been reported to work well. Artificial respiration can be started, if necessary, by placing a tube in one of the cria's nostrils, wrapping a hand around the nose to occlude the other nostril, and then gently blowing. Alternately, mouth to mouth resuscitation can be used. Blow sufficiently to fully expand the chest, remove your mouth, and let the chest deflate. Repeat 8 to 10 times per minute. Continue until the animal starts breathing on its own or the heart stops beating.

b) Abnormalities

– The major abnormality that you need to be aware of is CHOANAL ATRESIA. The Llama is an obligate nasal breather and animals with a choanal atresia are partially or totally unable to breathe through their nose. These animals frequently have difficulty breathing even when the membranes and mucus have been cleared. The problem is even more pronounced when the animals attempt to nurse. This is a problem that needs immediate attention by your veterinarian.

5) Postpartum Period:

a) Physiologic and Anatomic Changes:

i) Cardiovascular

ii) Intestines

– Although the adult Llama is functionally a ruminant and has the ability to digest plant material, the cria is functionally a non- ruminant (monogastric). During the first few weeks of life the rumen is poorly developed and the cria is dependent on the dam's milk for nutrition. Although some crias will start nibbling at grass and alfalfa as early as a few days postpartum, most crias will not be getting a significant percentage of their total calories from solid feed until several months postpartum.

b) Navel:

– Under most conditions, relatively little blood will be lost from the umbilical cord. If the cria is losing blood from cord, tie the cord off With a piece of string or cord soaked in betadine solution, leaving a stump about 1 inch long.

– Dip the navel in either 7% tincture of iodine or betadine (a "tamed" iodine) solution. The 7% iodine is probably a better choice since it dries rapidly and more completely than the betadine. The cord should be dipped at least 3 times for 30 seconds each time during the first 24 hours. Dipping the umbilical cord into a 35 mm film can containing the iodine works well. Although a spray bottle is a bit neater it doesn't coat the navel as well. Both the 7% iodine and the betadine strain everything quite nicely.

– The first dipping should be done within a couple of hours of birth.

– Dipping the navel is important to prevent infection with a wide range of common bacteria. Navel infections can spread to joints and can kill the cria. Treating animals with navel infections can be extremely difficult and some preventive care is worthwhile.

c) Standing:

– Most crias will stand up unassisted within 15 to 60 minutes. If the cria has not stood within 2 hours you will need to closely inspect and check the animal for limb or other problems. Most crias will have a harder time standing on a smooth floor.

– Concept: Handle the crias as little as possible during the first few days of life – they need to bond to the dam.

d) Colostrum:

– Colostrum is the antibody-rich milk fraction of milk produced by the dam. Since the immune system of the Llama (as well as essentially all other mammals) has not been exposed to bacteria and viruses at birth, the animal immune system is not producing antibodies at birth. Until the immune system of the cria really becomes functional (at 1 to 2 months of age having been sensitized to the normal environmental microorganisms) the cria is essentially totally dependent on the antibodies absorbed from the dam to protect it from a wide range of bacteria and viral infections.

– Due to nature of the Llama placentaessentially no IMMUNOGLOBULINS (antibodies) are transported from the circulatory system of the dam to the neonate before birth. As a result, the cria is totally dependent on getting colostrum for adequate antibody protection.

– Major concerns about antibody transfer:

a) Only the first milk (a thick more yellowish milk) contains the antibodies.

b) The cria is only able to absorb the antibodies from the intestines for the first 24 hours following birth.

– Due to the importance of the cria getting colostrum, watch and see that the cria nurses within the first 2 hours postpartum. Youwant to watch and see the cria nurse several times within the first 12 hours of life. Although some colostrum can be absorbed up to 24 hours postpartum, the best absorption occurs within the first 12 hours of life. Don't worry about the cria getting "too much" colostrum.

– The intestines o£ premature animals may close sooner than the intestines of a full-term cria.

– The absorption of colostrum will also be slowed in hypothermic (cold) animals.

– See Figures 5.2 and 5.3.

– Run your hand under the dam's belly and gently squeeze the teats on all glands. You should be able to get a drop or two of milk from each gland. This has the function of clearing debris, mucus, etc. from the tips of the glands.

– If the cria fails to get sufficient colostrum, the animal will have a PARTIAL or COMPLETE FAILURE OF PASSIVE TRANSFER (FPT). This problem will be discussed in section 6.A and article in 8H.

Enema:

– Function: Ensure that the animal is capable of passing normal feces.

– Enemas are not universally required. If the cria has been observed to defecate (typically a 3 to 4 inch long stool), no enema is required. It is important to differentiate MECONIUM (dark- colored) from the lighter-colored feces produced following nursing. If no meconium is observed, an enema should be used. Once the meconium has been passed, the animal will usually defecate normally thereafter.

– Extra large disposable drapes with a hole punched for the tail works well as a method of collecting the meconium.

– The DOSS enemas work well. The tip of the enema should be carefully inserted into the rectum and the plunger depressed. The typical volume is 10 – 12 ml. The enemas can be purchased from veterinary clinics. A similar volume soapy-water enema also works well. A 12 ml syringe can be used to administer the enema.

f) Weights:

– The normal birth weight for a Llama is between 20 and 30#s. While heavier crias are being reported, there is a concurrent increase in the percentage of birthing problems (dystocias) as birth weight increases. Animals weighing less than 20# deserve special attention. These underweight animals are frequently premature or dysmature animals. (See section 6.B for additional information).

– Get an accurate set of scales for weighing the crias. Although a bathroom scale will work in a pinch, they are not particularly accurate or reproducible. A small baby scale or produce scale with a range of up to 50# is ideal. Scales can be purchased at farm supply stores or via mail order (e.g., Nasco).

– Weigh and record the crias weight within the first 2 – 3 hours after birth. Watching a crias weight is one of the best means of assessing the animals health, and the initial weight will provide a frame of reference to check on the crias development.

– Most crias will start gaining weight rapidly following birth and should gain between 0.5 and 1.0 # per day for the first month of life. Normal animals will approximately double their birth weight within the first month of life.

– First-time mothers (PRIMIPAROUS) are sometimes a little slower than more experienced mothers (MULTIPAROUS) in reaching their full lactation potential. In these animals, milk production may be low for the first 1 to 2 days, and the cria may not start gaining weight for the 2 – 3 days. WATCH THESE ANIMALS CAREFULLY AND MAKE SURE THAT THE CRIA IS NOT LOSING WEIGHT. (See section 6.D for additional information.)

– Weight the cria twice (2X) during the first 24 hours postpartum and then daily at the same time each day for at least the next 7 days. If possible, continue weighing the animal on a daily basis for the first two weeks of life.

g) Temperature Regulation:

– Although the cria is a relatively hardy creature, it does have a large amount of surface area relative to its body weight and has tendency to lose heat. This is especially true immediately postpartum when the cria is wet. Animals that are born in exposed or wet conditions have the potential for becoming HYPOTHERMIC. Severely hypothermic animals may have rectal temperatures that fall below 90 F and most will die.

– Special attention should be paid to THERMOREGULATION (temperature regulation) in premature or dysmature animals. These animals frequently have problems maintaining body heat.

– If weather conditions are poor, bringing the animals into a barn or other shelter prior to parturition is encouraged.

– Warm animals before attempting to feed them.

h) APGAR and Check List:

– In human medicine 5 items are checked shortly after birth to assess the condition of the newborn. A modification of this for the Llama could include the following:

a) Color of mucous membranes:

– Should be pink. When a finger is pressed firmly against the gums color should return quickly once pressure is removed.

b) Heart rate: : 20-40 breaths/minute steady

d) Muscle tone/ear carriage:

– Ears should be erect. Good muscle tone (resists having leg gently stretched).

e) Temperature: ck-off list of things that should be done within the first few hours postpartum:

1. Iodine navel
2. Weight cria
3. Check dam for clear and open teats
4. Observe cria nursing
5. Selenium injections (if needed in your area)
6. Identify animal

i) Stress:

– Handle the animals as little as possible during the postpartum period. This is the time for the cria to bond to the dam antibody absorption to take place and the cria to discover its new environment.

6. Problems With the Neonate:

a) Failure of Passive Transfer (FPT):

i) Definition:

– Failure of passive transfer of immunoglobulins (antibodies) is a condition which develops when the cria does not receive and absorb a sufficient amount of colostrum during the first 24 hours following birth.

Colostrum Absorption of Immunoglobulins (Antibodies) in the Llama

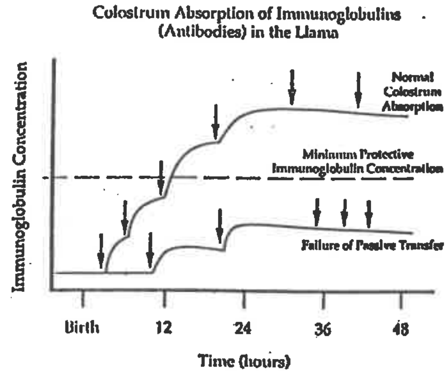
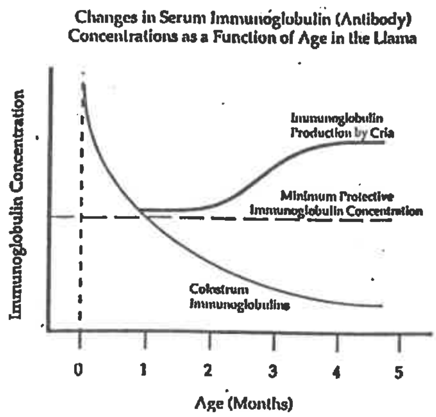


Figure 5.2 Antibody concentration in the cria as a function of time postpartum and the frequency of nursing.

Changes in Serum Immunoglobin (Antibody) Concentrations as a Function of



Age in the Llama

Age (Months)

Figure 5.3 Natural decline in antibody concentrations in the cria.

– It is not easy to determine if a cria has received sufficient colostrum. If the animal has been observed to have 2 or 3 good nursings within the first 12 hours, it is reasonably safe to assume that the animal has received colostrum.

- Be suspicious of animals that nurse poorly or have not been observed nursing.
- See attached article (Section 8H)

ii) Tests:

- Passive transfer can be evaluated in two ways:

a) Measure total serum-protein concentrations:

> 6.0 g/dl – adequate transfer
5.0 – 6.0 g/dl – some transfer
< 5.0 g/dl – little or no transfer

- These values assume that the animal is normally hydrated. These ranges provide only a rough indication of passive transfer and should be used with care.

b) Direct measurement of serum IMMUNOGLOBULIN (IgG) concentrations:

- The antibodies form a fraction in the blood that is referred to as the immunoglobulin or IgG fraction. See Figures 5.2 and 5.3.
- The most widely used tests are the zinc-sulfate turbidity and sodium-sulfite precipitation tests. Many veterinarians will be set up to run these tests in their office or on the farm. Both these tests involve collection of a blood sample, separation of the red blood cells (ERYTHROCYTES) from the serum, and measurement of the IgG concentration in the serum fraction. The test procedures are included in section 8.D of the appendix.
- Serum IgG concentrations can also be measured by ELECTROPHORESIS, an accurate but expensive technique and by radial immunodiffusion (RID), another technique done only in larger laboratories.
- See further explanation of teats in section 8D.

iii) Options:

- The available options depend largely on when the problem is detected.

a) First 24 hours postpartum:

- Feed colostrum. The best choice is frozen Llama colostrum. The next best choice is probably either goat or cow colostrum. While the goat colostrum MAY be more effective, it is also likely to be more difficult to find. Cow colostrum can usually be obtained at the local dairy. It is important to specify, however, that you want the first colostrum. The colostrum collected immediately after calving will have the highest IgG (antibody) concentrations.

- While goat colostrum may be somewhat better than cow colostrum, the potential for colostrum from goats infected with the goat virus CAE (caprine arthritis and encephalitis virus) to infect Llamas is unknown. Although it does not appear to be a problem, the Llama owner does need to consider the possibility. There also appears to be a higher incidence of SALMONELLA in goat herds than in Class A cow dairies.

- Synthetic colostrum: Synthetic cow colostrum (ColostrixTM) – available at farm supply stores) is freeze-dried cow colostrum that can be reconstituted when needed. Some owners have reported problems with the product.

- Concept: None of the colostrum replacements are as good as Llama colostrum. The Llama colostrum contains antibodies against the specific bacteria and viruses that affect Llamas.

- Volume: Give the crias 10% of their body weight during the first 24 hours. Divide the colostrum into feedings of 3 to 6 oz at 2 to 3-hour intervals.

After 24 hours:

- By 24 hours postpartum your options are decreasing. While feeding colostrum will continue to provide a good source of nutrition for the cria, it will not significantly increase serum immunoglobulin concentrations.
- If you suspect that the animal has not received colostrum, contact your vet, have him/her collect a blood sample, and determine if there has indeed been a failure of passive transfer.
- The options are: a) do nothing or b) do a plasma transfusion. The latter will require assistance from your vet.

b) Premature and Dysmature Crias:

- PREMATURE crias are those born following a shorter than normal gestation. Normal gestation for a Llama is approximately 350 days. Animals born more than 2 weeks early should be considered premature. Before considering a cria premature, however, make sure of the breeding date.
- DYSMATURE crias are those that had a normal length of gestation but are not fully developed.
- Some of the characteristics of premature and dysmature llamas

a) week and/or dehydrated
b) tipped ears
c) bottom incisors that have not broken the gum line (ERUPTED).

- Major considerations include:

a) inadequate development of the respiratory system
b) hypothermia
c) extreme need to get colostrum

c) Dystocias:

- It is difficult to make an accurate estimation of the incidence of some birthing problems in the Llama. Work from the Rocky Mountain breeders group suggests that as many as 1 in 20 births may be a dystocia (problem birth).
- The normal presentation for the Llama is with the front legs appearing just slightly before the head.
- The most frequent dystocias appear to be:

a) head back – only front legs appear
b) one or two front legs back

- Correction of the problem is going to require prompt attention. Call your vet as soon as possible and then do what is necessary until he/she arrives. A good source on information for the management of dystocias in the Llama is the "Llama Owners and Dystocia" manual published by Dr. LaRue Johnson Colorado State University.

d) Inadequate Milk Production

- The true incidence of the problem is unknown. It appears that the problem may be somewhat more common in first-time (primiparous) animals.
- Indications of inadequate milk production:

a) failure of cria to increase weight
b) dehydration of cria. The most readily seen indication of dehydration is that the skin loses its elasticity and "stands up" when lifted. If the animal is severely dehydrated the eyes may have a "sunken" appearance as well.

- Concept:"Do as little as necessary".

- General approach to problem:

a) Mastitis – Check dam for MASTITIS (inflammation of the mammary glands). The udder of animals with mastitis MAY feel unusually warm to the touch. Although mastitis appears to be relatively rare in the Llama if you think the dam has a mammary infection, call your vet and start treating the problem following his/her directions. b) Cross-nursing – Are there other crias in the same pasture that are nursing off the dam? If you think this might be a problem of snitching, separate the dam and her cria from the other crias.

c) Behavioral problems – Some dams particularly first-time mothers don't know what to do with the cria and will not stand to be nursed. Sometimes placing the dam and cria in a quiet secluded area helps.

d) Supplemental feeding – Supplemental feeding should be the last resort. Don't start feeding the cria until it becomes apparent that the dam is not going to produce sufficient milk to support the cria. If however the animal is obviously dehydrated supplemental feeding will be necessary. Once the cria is supplemented the lowered demand on the mother will decrease milk production.

- Commercial cow and sheep milk replacers are available. It is not clear that one or the other is clearly superior. The milk replacers can be purchased from most feed and grain stores and should be made up according to the directions on the bag. Milk replacer can be given by either tube-feeding or bottle.

– Tube-feeding

– Tube-feeding is the quickest and easiest way to feed a cria. Before tube-feeding an animal hold the tube against the animals side and estimate the distance between the corner of the animals mouth and the base of the neck. This is the approximate distance you want to pass the tube. The crias head is tipped up (slightly) and the K-Y lubricated tube slowly passed into the animals mouth. DON'T FORCE THE TUBE. If the cria will suck on the tube before is passed it will help the gastric groove close and more of the milk will pass directly into the third compartment. Apply gentle pressure to the tube and wait for the animal to swallow. The tube should pass easily down the throat.

– It is VERY IMPORTANT to make sure that the tube is not in the lungs. Putting milk into the lungs is a virtually guaranteed way to start a nasty case of pneumonia. Practical ways to check placement of the tube include:

a) Pass the tube to the premeasured length.

b) Feel the tube in the esophagus. It will feel like a second tube in the neck next to the trachea.

c) Notice if there is condensation in the end of the tube. If there is you are probably in the lungs.

d) Blow into the tube. If the tube is in the esophagus the rumen (abdominal region) will expand. Gurgling rumen sounds can also sometimes be heard.

e) Inject 10 – 15 ml of water into the tube. If the animal gags and/or coughs you are in the lungs.

– Bottle feeding

– Use of a bottle fitted with a lamb nipple works well. It has been suggested that bottlefed males have a greater chance of becoming "berserk males." While the BERSERK MALE SYNDROME is well established it is not clear that the behavioral problems are definitely related to bottle raising. Another potential problem is that once a cria is bottle fed it may not nurse the dam in preference to feeding from the bottle. If you decide to bottle raise the cria be prepared to feed it several times per day for the next 4 – 5 months.

– As a general approach, handle the animals as little as possible while feeding and don't feed them unless it is REALLY clear that the dam does not have adequate milk production. It is also important to remember that as the milk supplementation increases the nursing demand on the dam and the resultant milk production will decline.

– Volume: If the dam dies or has completely stopped milking feed the cria 10 to 15% of its body weight divided into 4 to 6 feedings per day after the first 7-10 days. During the first 7-10 days, feed every 2-3 hours or on demand by the cria.

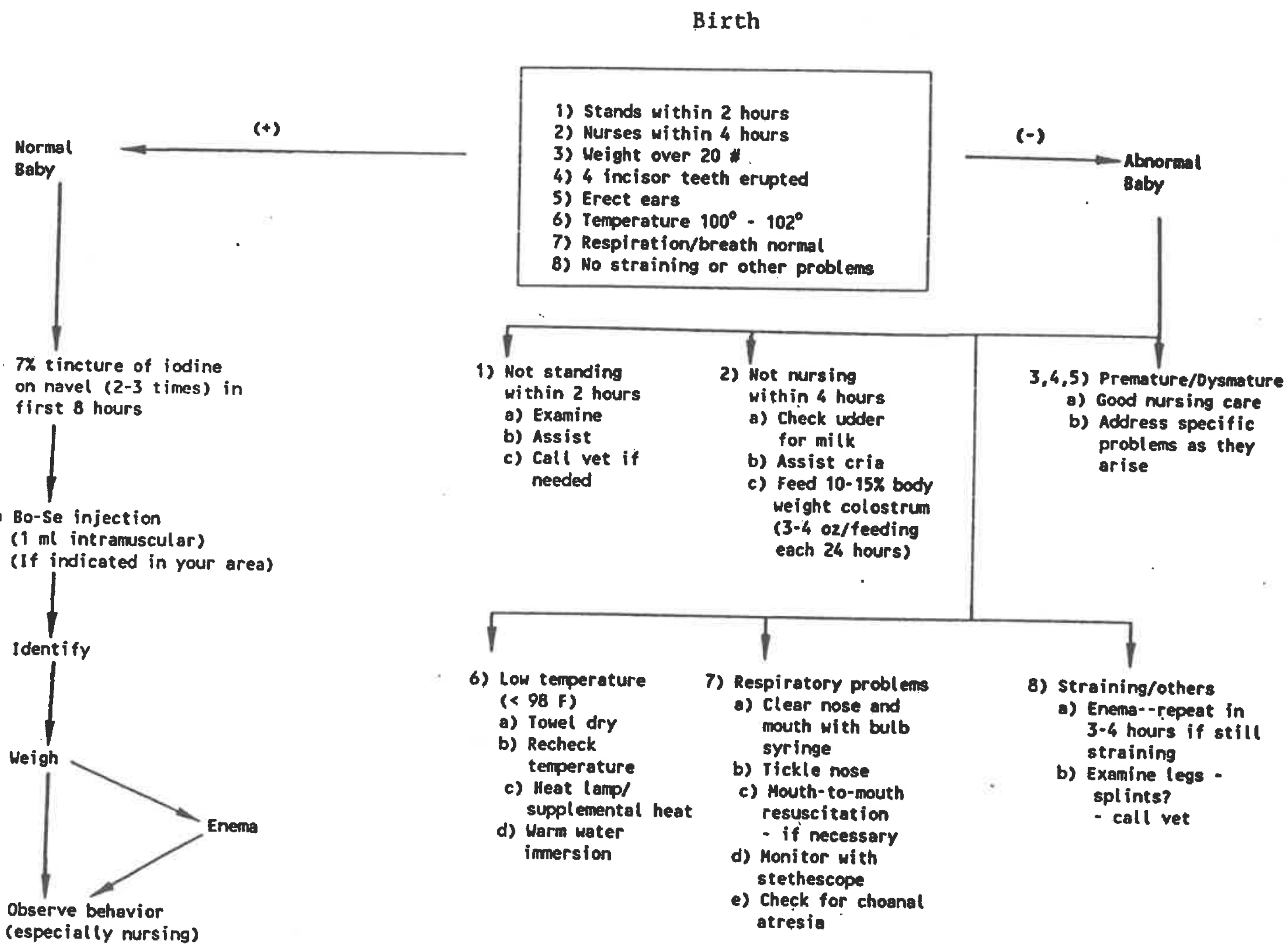
e) Physical Problems:

i) Choanal atresia – These animals do not have a normal connection between the nasal cavity and the rest of the respiratory system. These animals will gasp and show other signs of respiratory problems since they are unable to breathe while nursing.

ii) Atresia ani – another genetic problem in which the final portion of the large intestines are not connected to the anus. These animals will not be observed to have defecated since they lack an anal opening. Attempting to give an animal an enema will show the lack of an anal opening.

iii) Cardiac defects – A surprisingly high percentage of Llamas appear to have heart defects. Many of these defects can be detected listening to heart (left side usually works best) with a stethoscope. The most readily detected problems are heart murmurs. If you listen to all your crias you will very rapidly develop the ability to detect the abnormal animal.

iv) Angular limb deformity – Usually a problem with one or both of the front legs being "knocked kneed" and the legs not being straight. The legs of some crias will straighten up on their own within the first few days. Others may require splinting and a few will require surgery.



- With these and other physical problems, talk to your vet about different management and treatment options.

f) Summary

The following flow chart outlines one approach to the management of the normal and abnormal cria:

The Newborn Cria – Procedures for the Healthy and Sick Animal.

7) Care of the Dam:

a) Placenta:

– The placenta should pass within 4 to 6 hours postpartum. Spread the placenta out on the ground and check that none of it is still in the dam. It is suggested that gloves be used when handling the placenta on the slight chance that they are contaminated with bacterial or other agents that can affect the human. Use of gloves SHOULD ALWAYS BE USED when handling aborted fetuses and membranes. The careful disposal of aborted tissues, away from other wild and domestic animals, is important to prevent the spread of possible diseases.

b) Trauma:

– Check the vulva and surrounding region to confirm that the tissue didn't rip during the birth process. Occasionally a Llama will PROLAPSE (evert) her uterus. Contact your vet if the animal has vaginal or rectal tears or has prolapsed her uterus.

c) Lactation:

– Gently squeeze each teat and confirm that milk is flowing, from all quarters. Check for mastitis (inflammation of the mammary glands).

d) Nutrition:

– The postpartum dam should be continued on a higher plane of nutrition to ensure adequate milk production. Both the energy content and the % protein in the diet should be increased.

– Sudden changes in feed type should be avoided. The diet used during the last 2 months of pregnancy will usually be appropriate for lactation.

– Concept: Adjust feed levels as necessary to maintain body condition.

e) Rebreeding:

– Plan on rebreeding the dam 10 to 14 day postpartum. Confirm pregnancy 30 – 40 days later.

8) Appendix:

a) Supplies

The following is a list of first aid supplies to have on hand for both normal and problem deliveries:

- thermometer – mercury or electronic
- stethoscope
- iodine – 7% and/or betadine
- keep in small container (35 mm film canister) or spray bottle
- small wide mouth jar with thread/string soaked in betadine
- betadine scrub – soapy form of betadine solution
- lubricating gel – water based such as KY JellyTM
- Do NOT use a petroleum based lubricant
- J lube
- nitrofurazone cream (some people are very sensitive to nitrofurazone)
- 4 x 4 gauze pads
- Elasticon bandages (Ace bandages)
- scissors
- flashlight (one that works)
- duct tape
- colostrum (frozen)
- disposable plastic gloves
- bulb syringe
- stomach tube and feeding syringe
- plastic bottle and lamb nipples
- enemas
- towels
- Bo-SeTM and syringes
- ophthalmic ointment
- your vet's phone number

Keep all the supplies in one place, e.g., a fishing-tackle box. Things are tense enough at any delivery without having to look for the missing first aid supplies at the same time.

- scales – Should be able to accurately read to 0.5#.

b) Normal Values:

– Gestation length:About 350 days + 1 week

– Birth weight:	20 to 30#
– Stages of labor:	
1 – Preparation:	2 to 6 hours
2 – Fetal Expulsion:	up to 2 hours
3 – Passing of placenta:	4 to 6 hours
– Time to stand:	15 to 60 minutes
– Time to nurse:	within first 2 hours
Adult ts]100.0	– 102.0
– Respiratory rate: 10 – 30	10 – 40
– Pulse rate:90	– 140

c) Glossary of Terms:

Atresia ani – incomplete connection between the distal end of the large intestine and the anus, lack of anal opening

Cervix – muscular band of tissue separating the vagina and uterus

Choanal atresia – incomplete connection between nasal cavity and pharynx, apparently genetically-based problem

Colostrum – antibody-rich fraction of milk produced immediately postpartum

ColostrxTM – commercial cow colostrum replacer

Conception – fertilization of the egg

Corpus luteum – progesterone-producing structure on the ovary

Dexamethasone – a synthetic glucocorticoid used for arrange of problems, suppresses the immune system and can cause abortions

Dystocia – difficulty with birth

Erythrocyte – red-blood cell

Follicle – fluid-filled structure on the ovary containing the developing egg.

FSH – follicle stimulating hormone, produced by the interior pituitary and stimulates follicle development of the ovary

Glucocorticoids – a class of steroids produced by the adrenal gland, includes cortisol and related compounds

hCG– human chorionic gonadotrophin, has LH like activity, will induce ovulation

Hippomane – smooth, discoid, rubber-like, dark-brown masses floating in the allantoic fluid – probably aggregations of fetal hair and meconium

Hyperthermia – elevated body temperature

Hypothermia – decreased body temperature

Immunoglobulin – antibody

LH – luteinizing hormone – protein hormone released from the anterior pituitary causing the mature ovarian follicle to rupture

Mastitis – infection of the mammary glands

Meconium – fetal fecal material

Metritis – infection of the uterus

Morula – solid mass of cells formed following ferti]ization of the egg

Multiparous – females that have had multiple pregnancies

Nulliparous – female that has never been pregnant

Oviduct – uterine tube, the narrow duct that transports the egg from the ovary to the tip of the uterus

Parity – number of pregnancies – e.g., primiparous = first pregnancy, multiparous = multiple pregnancies

Parturition – the process of giving birth

Placenta – temporary structure formed from fetal tissues. Provides nutrient and gas exchange between the fetus and dam

Primiparous – First pregnancy

Postpartum – period of time immediately following birth

Progesterone – hormone produced by the corpus luteum

Prostagladin – a group of compounds that can cause regression (death) of the corpus luteum and lead to abortion or parturition

Pyometra – infection of the uterus

Tubal Pregnancy – implantation of the fertilized egg within the oviduct and not within the uterus

Vagina – short muscular connection between cervix and vulva

d) Measurement of passive transfer:

Methods:

RID: The definitive test for the measurement of Igs in blood is usually considered to be the radial immunodiffusion test (RID). The test is run in the laboratory and measures the absolute concentrations of immunoglobulins in serum. The test depends on having antibodies (usually produced in rabbits) that specifically react with Llama immunoglobulins. Only recently has this test been developed and validated for use in the Llama. While the test is currently being used at Oregon State University, the Llama specific version of the test is not widely available elsewhere in North America. One advantage of this test is that: it can be rapidly run and provides a mole accurate estimation of IgG concentrations than do the other tests.

Electrophoresis: A second test is "serum protein electrophoresis." very small serum sample is placed on a special gel and an electric charge applied to it. The different proteins in the serum move according to their electrical charge, i.e., so me to the positive and others to the negative poles. After a predetermined period of time, the electric charge is stopped and the proteins are stained and examined. While this approach provides a satisfactory estimation of IgG concentrations, it is slow, expensive, and requires a laboratory.

Total Serum Proteins: A third approach is to measure the total. serum protein concentration using a refractometer. After a blood sample has been collected and allowed to clot, the serum is removed and the protein concentration measured using a hand-held refractometer. Although it has not been fully validated for use in the Llama, it appears that total serum concentrations of < 5.0 g/dl are consistant with FPT, 5.0 – 6.0 g/dl are marginal, and > 6.0 g/dl may indicate sufficient IgG absorption. A good study on South American alpacas conducted at La Raya, Peru showed that mean serum protein concentrations in healthy crias increased from 4.7 g/dl prior to nursing to 8.0 g/dl at 24 hours.

Turbidity Tests: The turbidity test works by mixing serum samples with different concentrations of zinc sulfate or sodium sulfite and looking for a cloudiness or precipitation in the tubes. The tests are quick, easy, and give an indication of serum IgG concentration ranges, but have not been rigorously tested and evaluated for use in the Llama. Another frequently used test is the "Bova-S"TM test, a modification of the turbidity tests developed and validated for use in the cow. Although the accuracy and reliability of the test has not been adequately validated for use in the Llama, several clinicians and owners have reported success in using the test.

Sodium sulfite (Na2S03) precipitation test:

Reagents:

Concentrations (wt/vol) of 14, 16, and 18% Na2SO3, are prepared using 14, 16 and 18 g, of anhydrous Na2SO3, each in a total volume of 100 ml of distilled water. If Na2SO3, 7 H20 is used in instead of anhydrous Na2SO3, the amounts are 28, 32 and 36 g respectively.

Procedure:

0.1 ml serum is added to 1.9 ml of each of the 3 Na2SO3, solutions. Samples are mixed thoroughly and allowed to stand undisturbed for one hour at room temperature to permit maximum precipitation.

Visual interpretation:

Na2SO3 concentration (%)
Immunoglobulin
(mg/ml)– 5-l] (-) = no precipitation
(+) = flakes (light to heavy) of precipitation

Trace amounts of precipitation will sometimes occur that appear slightly cloudy but without definite flakes or precipitation. Slight cloudiness indicates that the Ig content of the sample is near the transition point between two concentrations.

Adequate colostral immunoglobulin absorption is evident with Ig levels > 15 mg/ml.

Partial failure of passive transfer = 5 – 15 mg/ml

Complete failure of passive transfer = < 5 mg/ml

Comments:

Use only serum because plasma samples contain fibringen and other clotting factors that are also precipitated by Na2SO3. Hemolyzed serum does not adversely affect immunoglobulin precipitation.

	Na_2SO_3 concentration (%)		
Immunoglobulin (mg/ml)	14	16	18
< 5	-	-	+
5 - 15	-	+	+
> 15	+	+	+

(-) = no precipitation
(+) = flakes (light to heavy) of precipitation

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ET

Embryo Transfer in the Llama

by Drs. Brad smith and Julie Farver Koenig Oregon State University

The concept of embryo transfer in the Llama is deceptively simple – the fertilized embryo is removed from a donor female and transferred into the uterus of a recipient animal where the embryo will develop to term. As a result of repeatedly collecting fertilized embryos from a single female, it is theoretically possible for her to "have" numerous, healthy crias each year. While the concept is simple, the practical aspects of embryo transfer in the Llama (and other species) are considerably more complex The process or embryo transfer (ET) involves coordinating the reproductive cycles of the donor and recipient animals, surgical or non-surgical removal of the embryo from the donor, location and evaluation of the embryo in the collection medium, and subsequent transfer of the embryo into the recipient's uterus. Following embryo collection, the donor female can be rebred and allowed to carry her pregnancy to term or continue serving as a donor.

To date, there has been only one reported case in North America of a Llama born as a result of ET. Although there are still technical difficulties with ET that need to be resolved in the Llama, this single case illustrates that successful ET is technically possible in the camelid. Before ET is widely used in the Llama and alpaca industries, however, there are also several philosophic and genetic considerations that need to be addressed. Primary amongst these concerns are questions of potential concentration of limited genetic material, expense, availability of the methodology, and registration of off-spring. Due to the complexity of the topic, this article will discuss separately the mechanics of embryo transfer, the genetic implications of ET, and the potential economic impact of ET on the Llama and alpaca industries. The article will not examine the question of how the International Llama Registry (ILR) might want to handle the registration of crias produced by ET.

Ovarian Function:

Before the mechanics of embryo transfer can be explained, an understanding of normal ovarian function is necessary. The ovaries of a mature Llama are spherical to oblong in shape and can vary between 0.5 and 1.5 inches in length. Although the ovaries grow between birth and maturing, the Llama already has all the eggs she will ever have in her ovaries at the time of her birth. There are thousands of immature eggs in each ovary – far more than the dam will use during her lifetime. Thus, even if eggs are repeatedly collected from an animal, there is no danger of her ever "running out" of eggs.

When a Llama reaches puberty, some of the eggs begin to grow and develop within the ovary (Figure 1). Although the initial growth is regulated by factors released within the ovary, complete maturation of the egg requires the presence of FSH (follicle stimulating hormone), a hormone released into the circulation from the pituitary gland. The pituitary is a small gland – sometimes referred to as the "master gland" – that is located at the base of the brain. In the presence of FSH, some of the eggs begin further development and growth. As the eggs mature, the ovarian tissue enveloping the eggs begins to swell and fill with fluid. This blisterlike structure contains the developing egg and is called a FOLLICLE. Still under FSH stimulation and to a lesser extent LH (luteinizing hormone, another pituitary hormone), the follicles continue to grow until they bulge above the surface of the ovary. When, the follicles reach a certain size, they begin to secrete estrogen. It appears that the secreted estrogens (primarily estradiol) play a major role in the female's receptivity to the male.

One of the unique features of the Llama is its similarity to the cat, rabbit, and ferret – all are induced ovulators. As a result, ovulation does not occur until after breeding. In contrast, dogs, and most domestic livestock species (cattle, pig, etc.) ovulate at regular intervals during their reproductive cycles irrespective of the breeding stimulus. During mating in the Llama, it appears that the tip of the penis stimulates the cervix resulting in a signal being sent to the animals brain (Figure 2). Work in the camel has suggested that factors in the semen, presumably absorbed following mating, may also play a role in stimulating the brain. The signal sent to the brain stimulates the release of a large quantity of LH from the pituitary within a few hours following mating. This LH surge causes a gradual weakening of the surface of mature fluid filled follicle (Graafian follicle). Eventually the wall of the follicle ruptures and the egg is released (approximately 1.8 days after mating). The egg is picked up by the uterine tube (oviduct) and carried towards the uterus.

After ovulation, the follicle rapidly fills with blood. The cell layers the follicle also begin to change and grow towards the centre of the follicle. Within a few days, the structure of the follicle has completely changed into another structure, the CORPUS LETEUM (CL). The CL is usually spherical in shape, approximately 0.5 inches in diameter, and bulges above the surface of the ovary. Within 5-6 days following mating, the CL has formed and started to release substantial amounts of progesterone, the primary hormonal stimulus causing the female to reject the male. If the animal becomes pregnant, the CL will continue to produce progesterone until approximately 24 hours prior to delivery. High progesterone concentrations (>1.0 ng/ml) are necessary to maintain pregnancy. If the animal does not become pregnant, the CL will regress (die) within 15 days following initial mating. As the CL regresses, progesterone production declines. The CL eventually become a nonfunctional ovarian structure – the CORPUS ALBICANS. When the blood progesterone concentrations decline, estrogens produced by developing and mature follicles will once again make the female receptive to the male.

Embryo Transfer

The basic assumption when discussing donor and recipient animal for ET is that they are both reproductively sound. This definition implies that they have the ability to ovulate and produce a CL. Under ideal conditions, both animals should have the ability to conceive and carry a cria to full term. The reality of how ET would likely be used in the Llama and alpaca industry, however, is that some recipients would not be completely normal. When dealing with animals that have some reproductive problems, the role of ET becomes more complex and will be briefly discussed later in the article. The following section dealing with the mechanics of ET, however, assumes that both animals are reproductively sound. The mechanics of ET are summarized in Figure 3.

Donors: For ET to be an effective tool in the Llama and alpaca industries, careful donor selection is critical. The donor should be reproductively sound and of superior genetic quality. While there will be disagreement as to the characteristics of the genetically superior animal, at a minimum, the animal should be structurally sound, have good mothering and milking ability, and be free of ALL genetically based defects.

Once a donor has been selected, there are two conceptual approaches to her management. The first, and simplest, method is to allow the female to be bred naturally. Breeding the female more than once increases the probability that the ovulated egg is fertilized. Using this technique, one follicle will rupture, resulting in, at most, one fertilized egg being available for transfer.

The second approach involves causing the donor animal to SUPEROVULATE. This method is widely used in other species (particularly the cattle industry) and could probably be used in the Llama as well. The donor animal is injected with FSH or a related compound (PMSG) causing a larger number of eggs to mature (Figure 1). When the animal ovulates, more eggs are released and fertilized. With superovulation, 1 to > 10 embryos might be collected following a single mating. The advantage of superovulation is that potentially more offspring can be produced from a given female and the probability of finding an embryo in the flesh medium is increased. The disadvantage is that the technique has the potential to cause some problems with subsequent ovarian function. In light of the value of female Llamas, and the potential for problems – it is unclear if the theoretical benefits of superovulation outweigh the potential problems in the Llama.

Recipients: The ideal recipient is the reproductively sound darn that has given birth to a cria with choanal atresia or other genetic defects. Because she carries the genes for a genetic defect she is "genetically defective," and the ethical breeder would not allow her to conceive again. By using her as a recipient, however, she can still be reproductively active without perpetuation of her inferior genes.

A successful ET program requires that the recipient female's cycle be synchronized with that of the donor. There are two possible approaches to preparing the recipient female. The easiest approach is to breed the recipient to a vasectomized male (an animal that has been surgically altered so that no sperm can pass to the female). Mating by the vasectomized male will cause the recipient to ovulate, produce a CL and prepare the uterus for an embryo. Although her own unfertilized egg will degenerate, her uterus will be ready to accept an embryo from the donor. The second approach is induction of ovulation with injectable hormones. The hormone hCG (human chorionic gonadotrophin) is readily available and has biologic activity that is essentially the same as that of LH (Figures 1 and 2). If a mature follicle is present on the recipient's ovary, administration of hCG will cause ovulation. The appropriate dosages for use in the Llama have not, however, been established.

Flushing and Embryo Collection:
Embryos from donor females can be collected either surgically or non-surgically. Surgical collection involves general anaesthesia and surgically opening the abdomen. In contrast, the non-surgical collection procedure does not involve surgery and is considerably safer for the donor. In comparison to surgical collection techniques, however, the probability of collecting embyros is also somewhat lower using non-surgical approaches.

– With non-surgical collection, the embryo is flushed from the uterus six to eight days following fertile mating. The technique involves restraining the donor in a chute while a thin catheter (tube) is then passed up the vagina, through the cervix, and into the uterus. A balloon near the tip of the catheter is inflated to keep the tube within the uterus. The uterus is filled with a sterile flushing solution until distended, then allowed to drain into sterile containers. The sequence is repeated several times until 300 – 600 ml of flushing medium have been collected.

The flush solution is then allowed to stand while the embryo(s) sink to the bottom of the flask. After most of the fluid is poured off, the remaining medium is examined under a high powered dissecting microscope. This part of the procedure can be time consuming and frustrating since an embryo is not always found. Once the embryo has been located, its condition is evaluated to determine if it appears viable and thus should be transferred. While the flushing and embryo collection portion of the procedure sounds straight forward, very little is known about the optimum flushing medium, the best time for embryo collection, and the mechanics of embryo flushing in the Llama and alpaca.

Embryo Transfer to recipients: Once the embryo has been identified and evaluated, it is placed into a thin tube which is inserted through the cervix of the recipient and the embryo is deposited into the uterus. The entire procedure, from embryo collection to completion of the transfer, can usually be completed in 2-6 hours.

Pregnancy Diagnosis: Due to the large number of unperfected techniques the initial pregnancy rates in the recipients will be low. It should also be remembered that even under optimal conditions, there is a significant embryonic loss in normal animals during the first month of pregnancy. As techniques are improved, however, the pregnancy rate should increase. The success rate in large commercial cattle ET stations varies between 60 and 70% following a single transfer. Pregnancy in the Llama should be confirmed by rejection of the male 15-18 days following ovulation and a blood progesterone test after an additional 15-30 days.

Figure 1:
Diagrammatic representation of a typical Llama ovary. The pituitary hormone FSH is primarily responsible for stimulating initial development of the eggs while LH causes the mature (Graafian) follicle to rupture following ovulation, the follicle develops into a corpus luteum (CL) and in 5-6 days begins secreting progesterone if the female does not become pregnant, the corpus luteum will repress (die) and become a non-functional corpus albicans. As the CL regresses, progesterone production stops.

Figure 2:
Sequence of events associated with mating and ovulation in the Llama. Mating (1) sends signals to the brain (2) stimulating the release of the hormone LH from the anterior

Table 1:

Advantages and Disadvantages of Embryo Transfer in the Llama

Pros:

1. Generally defective animals could be used as recipients and de facto culled from the genetic pool. The incidence of some genetically based defects (eg. choanal atresia, syndactylism etc.) would decrease.
2. Structurally unsound, poor deposition, etc. Llamas could be recipients for embryos from other superior Llama.
3. A genetically superior female could be used as a donor to produce more than 1 cria per year.
4. Extend the reproductive life span of studs on small farms by using their daughters as recipients and therefore decrease inbreeding.
5. Research in genetic diseases of the Llama. With multiple progeny from the same cross, modes of inheritance, frequency of occurrence, etc. could be determined.
6. The value of females who carry the gene for a genetic defect, as well as poor quality females might increase due to their potential use as recipients.
7. ET represents another approach to the importation of new genetic material from South America and elsewhere.

Cons:

1. Expense.
2. Require access to trained personnel and facilities.
3. Embryo collection could potentially result in injury and/or impaired production in either the donor or recipient.
4. Without prudent use, Et could result in a further decrease in population genetic diversity.
5. Sustantially less than 100% of the donors embryos will result in the birth of a cria.
6. Value of top quality animals might be depressed.
7. Reproductive cycles of donor (or recipient) open until the recipient (or donor) is also available.
8. If either the donor dam and/or her mate are carriers of the genes for defects, the incidence of these problems could be increased.

pituitary, a small gland at the base of the brain (3). The surge of LH causes the follicle to rupture (4) releasing the egg (ovum) approximately 1.8 after mating.

Figure 3:

Conceptual approach to the use of embryo transfer in the Llama.

Genetic Considerations

While the logistics of embryo transfer in the Llama and alpaca are not trivial – it has been shown to be feasible. With further research and refinement of techniques, the methodology for ET in the Llama and alpaca can be perfected. Before the technique is used widely, however, the genetic implications of ET need to be carefully considered.

In general, the greatest genetic improvement is made within a species when a relatively small number of high quality animals are used as breeding stock. In many livestock industries, less than 70% of all available females and less than 25% of the males are returned as breeding stock. The remaining animals are culled from the breeding population. To date, most of the improvement within the Llama industry has come from selection on the male side. Due to the rapid growth rate of the industry and the great demand for animals, essentially all females have been used as breeding stock. Unfortunately this approach has resulted in the perpetuation of some poor quality females; specifically those who are genetically, conformationally, and/or reproductively defective. Use of these "defective" animals as ET recipients effectively removes them from the breeding pool – de facto culling them. Elimination of these animals will also result in an improvement in the average quality of the breeding stock females and subsequently their offspring.

Another potential advantage of using ET is that it could effectively increase the useful reproductive lifespan of superior sires on small farms. By using a sire's daughter as a recipient it would be possible for her to have multiple offspring without mating her to her father, avoiding the problems of inbreeding. In addition to the production benefits of ET, the technique would also be a useful research tool, permitting scientists to more easily investigate the heritability and mode of inheritance of specific defects in the Llama.

The strongest argument against the use of ET in the Llama and alpaca industries is its potential to decrease the genetic diversity of the species. For example, if only 10% of the females were used as donors and the remaining 90% as recipients, there would be a significant decline in the diversity of the gene pool. In contrast, if only the poorest 10-25% of females were used as recipients, ET would have minimal impact on the overall genetic diversity of the industry while decreasing the incidence of genetic defects – eg. choanal atresia

Another risk with ET is the inadvertent selection of "genetically defective" females as donors. The worst scenario would be the mating of animals that each carried the gene for an undesirable trait. While the parents would both appear (phenotypically) normal, 25% of their offspring would have the defect and 50% would be carriers for the defect. Only 25% of their offspring would be normal and not be carriers. The incidence of this scenario is difficult to predict since the mode of inheritance (eg. simple recessive, etc.) for most defects in the Llama is unknown. With careful selection of parents and the careful monitoring of their offspring, this problem can be minimized.

Economic Considerations

Initial ET efforts are likely to be relatively expensive ($1000 – $2000 per transfer) and the success rate will be variable and likely low. Initially, as < 25% of collected embryos might result in a cria. Experience in the cattle industry has shown that as the techniques for ET were refined, the success rate increased and the resultant cost per pregnancy dropped substantially. It is reasonable to assume that the same changes would apply to ET in the Llama and alpaca industries as well.

The impact of ET on the Llama and alpaca markets is hr more difficult to predict. Presumably owners would be selecting their best animals as donors. This would result in a larger number of higher quality animals becoming available. The market impact depends largely on the number of ET animals produced, the growth rate of the camelid market, and the ILR's position on registration. The value of low quality females, particularly those carrying genes for genetic defects, would likely increase due to their potential use as recipient animals. If the market continues to grow, the introduction of a large number of good quality animals should not significantly depress prices. If the market stagenates, top prices will decline with or without ET techniques. Finally ILR decisions concerning an open or closed registry, ability to register ET animals etc. may have a dramatic effect on the value of ET in the industry.

Final Considerations

Embryo transfer is a potentially valuable tool that could be of substantial benefit to the Llama and alpaca industries. Like most powerful tools, however, it is a double edged sword that could damage as well as help the industry.

The most persuasive argument against the use of ET in the Llama is the potential for a further reduction in genetic diversity in an already small gene pool. The significance of this argument depends largely on how frequently and carefully the technique is used. If a relatively small number of females from a few bloodlines are extensively used as donors with a large pool of recipients, genetic diversity will decrease. In

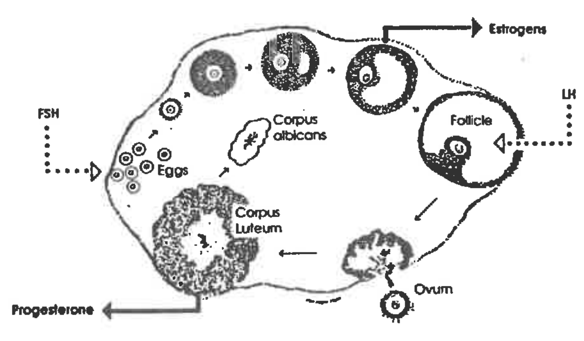


Figure 1:
Diagrammatic representation of a typical llama ovary. The pituitary hormone FSH is primarily responsible for stimulating initial development of the eggs while LH causes the mature (Graafian) follicle to rupture. Following ovulation, the follicle develops into a corpus luteum (CL) and in 5-6 days begins secreting progesterone. If the female does not become pregnant, the corpus luteum will regress (die) and become a non-functional corpus albicans. As the CL regresses, progesterone production stops.

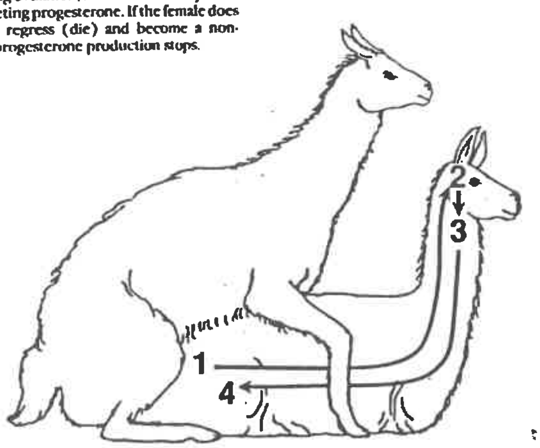


Figure 2:
Sequence of events associated with mating and ovulation in the llama. Mating (1) sends signals to the brain (2) stimulating the release of the hormone LH from the anterior pituitary, a small gland at the base of the brain (3). The surge of LH causes the follicle to rupture (4) releasing the egg (ovum) approximately 1.8 days after mating.

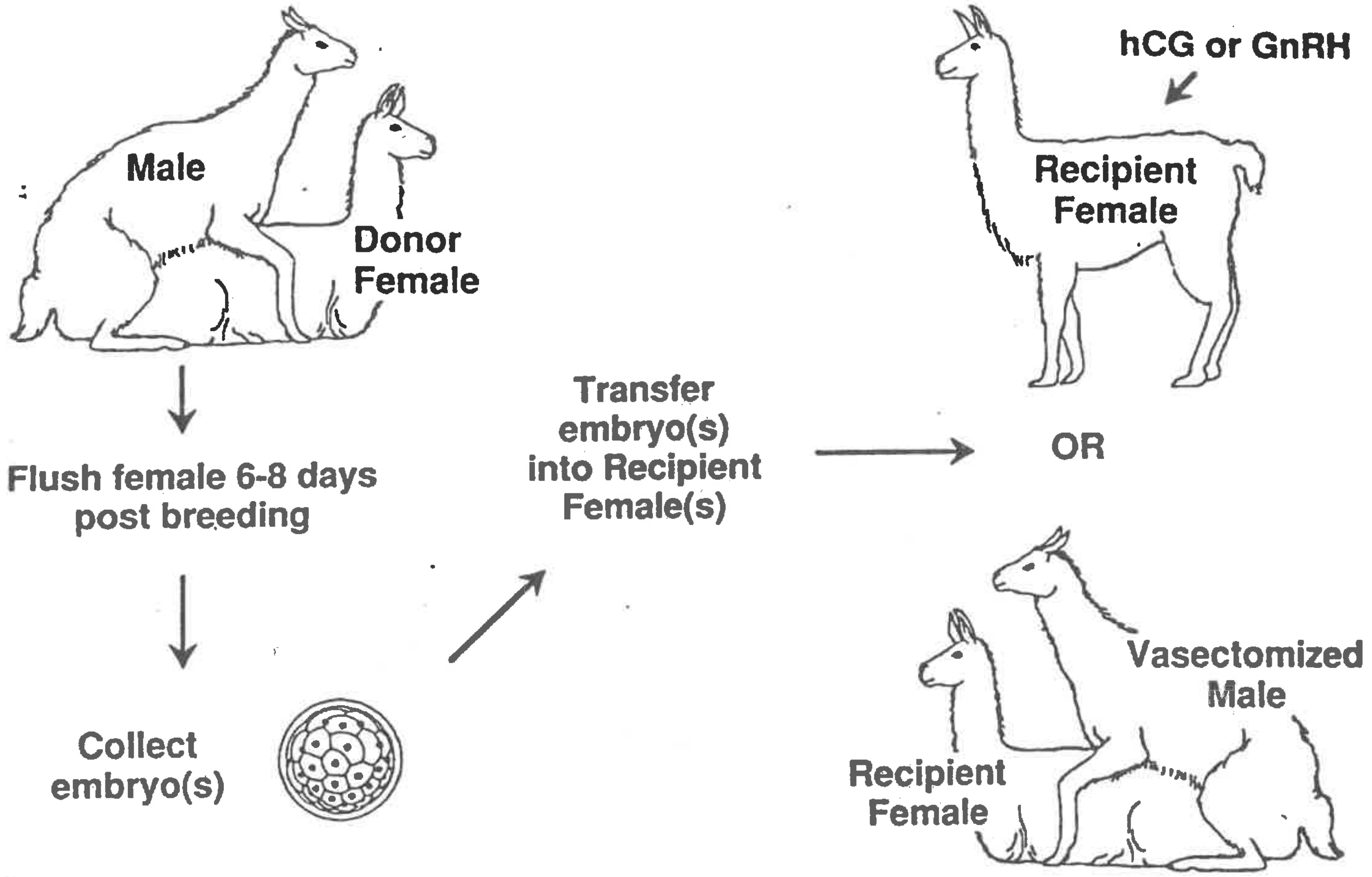


Figure 3:
Conceptual approach to the use of embryo transfer in the llama.

contrast, if the technique is selectively used, it has the potential to substantially strengthen the North American camelid industry by functionally removing poor quality animals from the gene pool.

In evaluating the arguments for and against ET in the camelid industry, a recurrent and central theme is the identification of "genetically superior" breeding stock, an elusive goal. In industries with "end markets," identification of superior animals is a relatively straight forward process. For example, in the dairy industry, milk production, mothering ability, ease of birthing and other factors are quantifiable traits that are used as the basis for selecting breeding stock In the swine and poultry industries, feed efficiency, rate of gain, fat deposition, etc. are all used as selection criteria. A single set of selection criteria for the Llama and alpaca industries has not been defined since their is little consensus as to the "best" appearance and function for the "final product."

If ET is to be effectively used in the North American camelid industries, defining the characteristics of "generally superior" animals is essential. While there has been pressure on breeders to produce animals with long wool, banana ears, dark colors and flashy markings, these characteristics should be considered as secondary to the animal's overall soundness. The fundamental criteria for the selection of breeding stock has to focus on correct conformation, good health, the absence of genetic problems, and reproductive soundness (eg. fertility, mothering and milking ability, etc.). Only after animals meet these primary criteria, should other traits be considered. Assuming that the industry, researchers, and veterinarians can define what constitutes "superiority," the careful and selective use of ET will strengthen the camelid gene pool in North America and functionally provide a method for female culling – an important management tool and requirement for maximizing the rate of genetic progress.

Pregnancy in the Llama: Hormonal Changes

by Brad Smith, D.V.M., PhD, Oregon State University

Introduction

A infertile mating in the Llama usually lasts 10 to 45 minutes with the end result being the delivery of a cria almost a year later. During the intervening period, the egg released from the dam's ovary was fertilized, transported into the uterus, implanted in the wall of the uterus, grew by repeated divisions and finally developed into a cria. This development, from a single fertilized egg to the delivery of a full term healthy cria, is one of the most complex and intricately controlled biologic processes known to mankind. Hormones produced by the ovaries and placenta play a central role in the regulation of this development and will be the focus of this article. Unfortunately, problems with the regulation of normal development at any time during pregnancy can result in abortion, developmental problems and premature birth. This article will also examine the possible role of hormone deficiencies in abortions and premature births.

Hormonal Changes During Pregnancy

In the rat, human and cow, more than a dozen different hormones are known to be involved in the regulation of pregnancy, fetal development and parturition (delivery). These include such diverse hormones as progesterone, insulin, growth hormone and oxytocin. Although far less is specifically known about the Llama and alpaca, the same hormones are presumed to exert similar functions in these species as well.

Hormones are loosely classified according to their physical characteristics as steroid or protein hormones. In general, once released into the body, the steroid hormones (eg. progesterone and estrogens) persist in the circulation for a relatively long period of time (hours to days). In contrast, the protein hormones (eg. luteinizing hormone or LH) last for only a short time following release (minutes to hours). The protein hormones involved in the regulation of pregnancy in the Llama and alpaca are primarily produced by the anterior pituitary (a gland at the base of the brain) and perhaps by the ovary. (See Llamas, Basic Physiology of Reproduction in Female Llamas, Vol. 4, No. 3, p 35).

Production of the steroid hormones involves different tissues. The corpus luteum (CL) is a temporary hormone producing structure formed in the ovary following the rupture of a follicle and release of an egg. (See Llamas, Vol. 4, No. 1, p 29). The primary steroid hormone produced by the CL is progesterone. In the pregnant animal, the placenta is a second steroid-producing tissue in most species. The placenta in many species produces large amounts of progesterone during the latter stages of pregnancy as well as large amounts of two closely related estrogens, estradiol-17B (E2B) and estrone (E1). The physiologic functions of progesterone, E1 and E2B will be discussed later.

The adrenal glands, located just in front of the kidneys, also produce various steroid hormones including cortisol. This steroid is particularly important since there is strong evidence that the release of cortisol from the fetal adrenal glands may be a central factor in initiating the birth process in some species. The involvement of cortisol and related compounds in initiation of the birth process also points out one of the potential dangers of administering even moderate dosages of cortisol or related compounds during pregnancy. Large dosages of the synthetic cortisol-related products (eg. Dexamethasone, Betamethasone, etc.) can cause abortions or premature births.

Physlologic Function of Progesterone and Estrogens

The biological effects of progesterone are well established in many species and are presumably similar in the pregnant Llama following mating, the ovarian follicle ruptures and starts its transformation into a CL. By four to five days following mating, the CL is producing significant amounts of progesterone. The rising progesterone concentrations produce distinct behavioral changes in the female specifically refusing or "spitting off" the male. This increase in progesterone production also produces some important uterine changes. The elevated progesterone stimulates development of the lining of the uterus (endometrium) in preparation for implantation of the fertilized egg. Progesterone also has the important effect of "quieting" the smooth muscles of the uterus. When the female has high progesterone concentrations (>1-2 ng/ml), the uterine muscles are relatively insensitive to stimulation. As a result, when the fertilized egg develops and implants in the uterine wall, the uterus does not contract, expelling the egg. This "quieting" effect on the uterus is extremely important throughout pregnancy since once the progesterone concentrations decline (probably to <C0.5-1.0 ng/ml), the uterus will begin to contract and abort the fetus.

During the later stages of pregnancy, progesterone, in combination with the estrogens, plays an important role in stimulating the development of the mammary glands. The estrogens also play an important role in preparing the dam for birth by helping to relax the cervix shortly before birth.

Steroids and Pregnancy

Until recently the steroid hormone changes associated with pregnancy in the Llama were poorly understood. As part of his PhD thesis, Dr. Juan Leon, a Chilean veterinarian working in the author's laboratory, studied the normal hormone changes associated with pregnancy. The study involved blood sample collection at regular intervals from mating until seven days following the delivery of healthy full term crias in 14 Llamas. Partial results of his research are down in Figures 1 and 2.

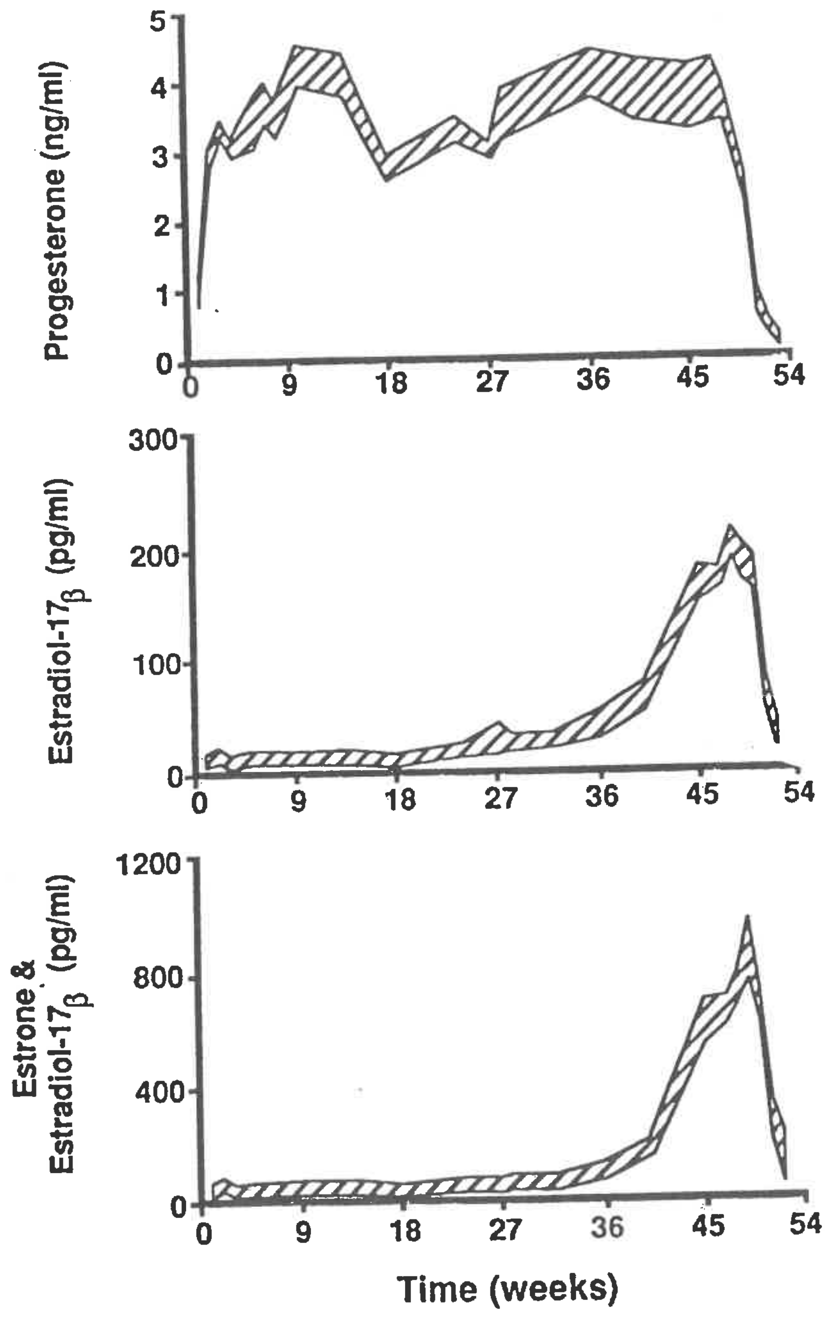
Figure 1 shows the changes in blood progesterone and estrogen concentrations from the time of mating until one week following delivery. The shaded regions are the result of statistical evaluation of the data and represent the range of concentrations observed in approximately 2/3 of the individuals at a similar stage of pregnancy. This distinction is important because there were individual animals with higher (>6 ng/ml) and lower (<2 ng/ml) progesterone concentrations that had normal full term crias. It was also interesting that progesterone concentrations varied by as much as 4 ng/ml in samples from the same animal taken only two weeks apart. The progesterone concentration in one animal was as low as 1.2 ng/ml for a few samples and yet she still had a healthy full term cria.

Figure 1: Temporal changes in progesterone and estrogen concentrations from mating until seven days following delivery. While the progesterone probably comes either primarily or exclusively from the corpus luteum of the ovary, the estrogens (estradiol and estrone) likely come from the placenta. The gradual decline in progesterone and the estrogens prior to delivery is somewhat deceptive since the length of the pregnancy in the 14 study animals differed slightly.

The dip in progesterone concentrations between approximately four and six months of gestation was also consistently observed although the significance of this decline if any is unknown.

The increase in estrogen concentrations during the last third of pregnancy is similar to the changes seen in many other species. Based on work in other species the increase in estrogen concentrations is probably the result of increased estrogen production by the placenta. This increase in estrogen production probably prepares the uterus for delivery of the cria and the mammary glands for milk production.

While the data in Figure 1 were plotted as a function of time in weeks since mating the data in Figure 2 were adjusted and plotted as a function of time in days relative to the day of delivery (Day 0). Figure 2 shows the



Time (weeks)

Figure 1: Temporal changes in progesterone and estrogen concentrations from mating until seven days following delivery. While the progesterone probably comes either primarily or exclusively from the corpus luteum of the ovary, the estrogens (estradiol and estrone) likely come from the placenta. The gradual decline in progesterone and the estrogens prior to delivery is somewhat deceptive since the length of the pregnancy in the 14 study animals differed slightly.

sudden decline in progesterone concentrations during the last 48 hours prior to delivery. This sudden change in steroid hormone concentrations is probably a critical factor in starting the birth process. Figure 2 also shows that progesterone production by the corpus luteum (and perhaps the placenta) begins to decline at least a week prior to delivery before dropping precipitously in the 48 hours prior to delivery. Without sufficient progesterone concentrations (>0.5-1.0 ng/ml a Llama will not remain pregnant.

In contrast to the progesterone concentrations the estrogen concentrations remain elevated until immediately before delivery. This supports the idea of the estrogens being produced exclusively by the placenta since they remain elevated until the placenta is expelled. It is also interesting to note the differences in absolute concentrations of the estrogens and progesterone. The estrogens are measured in units of pg (picograms) per milliliter (ml) while progesterone is in units of ng (nanograms) per ml. Since there are 1000 pg per ng it is apparent that during early pregnancy the ratio of progesterone to estrogen concentrations is>100:1 while at the end of gestation this ratio declines to <5:1 This ratio is believed to be another critical factor in the regulation of the birth process.

Progesterone Deficiencies as a Cause of Abortions

When discussing fertility problems with Llama owners a frequently asked question is:

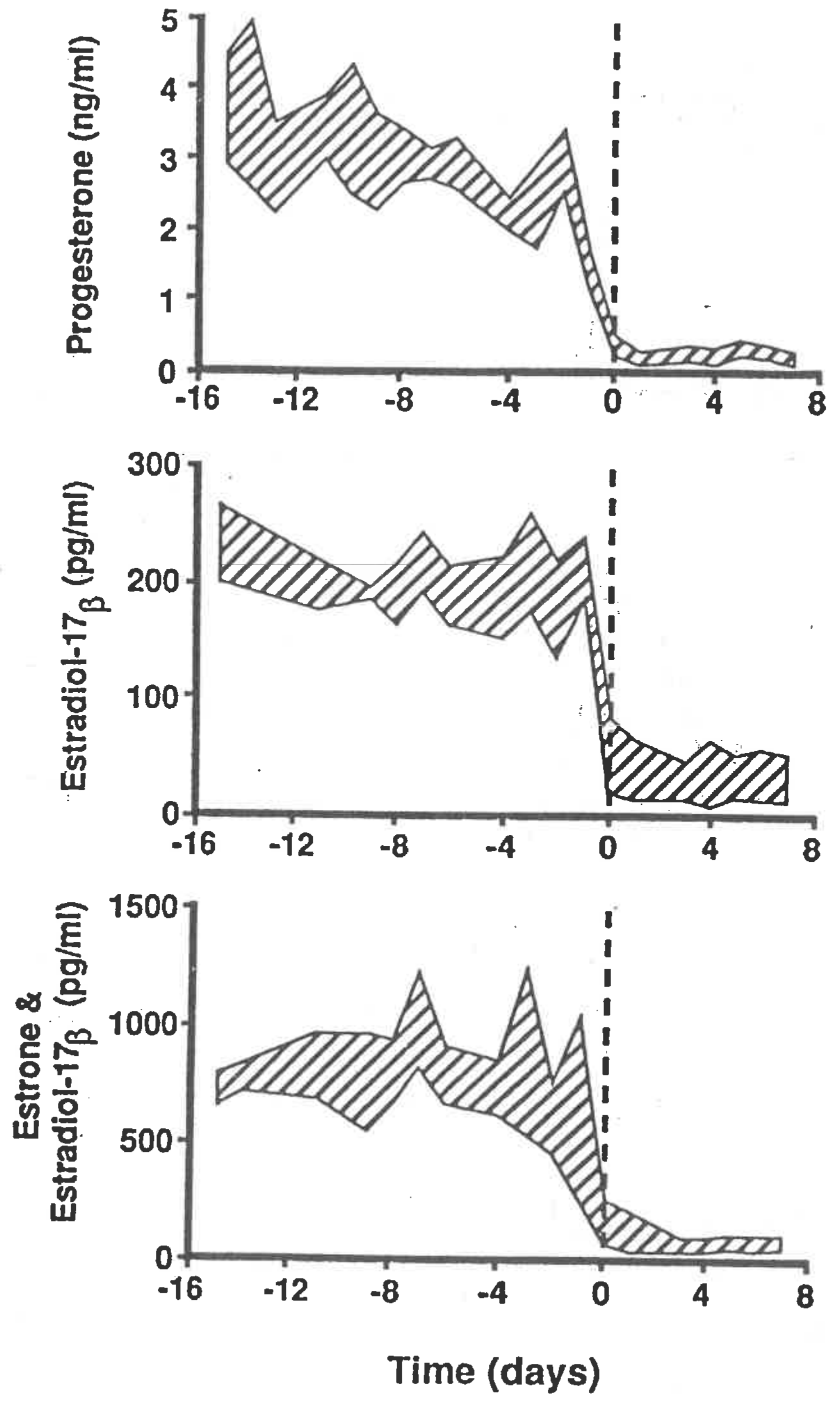
Figure 2: Changes in progesterone and estrogen concentrations for the 15 days preceding and seven days following the delivery (Day 0) of a healthy full term cria. It is interesting to note the gradual decline in progesterone concentrations during the last two weeks prior to delivery and the abrupt decline in the 24 hours immediately preceding birth. In contrast, the estrogen (estradiol and estrone) concentrations did not change until immediately prior to birth.

"If progesterone is essential for maintaining a pregnancy and my Llama keeps aborting 30-60 days after mating should I give her progesterone injections?"

A variation on the same question is:

"My Llama has bad a premature cria the last two years should I give her progesterone shots?"

The answer to both questions is "It depends." The underlying assumption behind both questions is that the corpus luteum and/or the placenta is not producing enough progesterone to prevent the uterus from contracting and aborting the fetus. In the case of the Llama it has never been demonstrated that an animal aborted because of insufficient progesterone concentrations. It is also a question that has never been carefully researched. Under experimental conditions it has however been reported that surgical removal of the



Time (days)

Figure 2: Changes in progesterone and estrogen concentrations for the 15 days preceding and seven days following the delivery (Day 0) of a healthy full term cria. It is interesting to note the gradual decline in progesterone concentrations during the last two weeks prior to delivery and the abrupt decline in the 24 hours immediately preceding birth. In contrast, the estrogen (estradiol and estrone) concentrations did not change until immediately prior to birth.

Llamas ovaries did cause her to abort.

There is some evidence for inadequate progesterone production being a cause of abortions in the mare although this conclusion has been challenged in at least one recent research paper. There are several aspects of reproduction in the mare that are unique to this species and there is some indication that some mares may indeed abort during the first 60-100 days following mating due to insufficient progesterone production. In these animals supplemental progesterone does seem to improve the fertility rate.

The data to support progesterone deficiencies in other domestic species is weak at best. Although there are anecdotal reports of progesterone supplementation preventing abortions in the cow, these reports should be viewed as just that – anecdotal. Before Llama and alpaca owners start treating all fertility problems with supplemental progesterone there is a long list of other possibilities that should first be excluded. This process involves working with your veterinarian and systematically determining among other things:

- Is the male fertile?
- Does the female have a complete reproductive system?
- Is she old enough?
- Does she have an infection of the reproductive system?
- Does she have other medical problems?
- Is she ovulating following mating?

As this partial list indicates, there are a large number of conditions that can produce fertility problems. While a progesterone deficiency might occur in a very small percentage of Llamas and alpacas, this condition should be relegated to near the bottom of likely causes of early abortions. If the role of insufficient progesterone production in early abortions is unclear, the involvement of inadequate progesterone production in premature births is even less clear. To the best of the author's knowledge, inadequate progesterone production as a cause of premature birth during late pregnancy has never been demonstrated in the Llama or alpaca. The diagnosis of inadequate progesterone production as a cause of a cause of abortion or premature delivery is one of exclusion and should be viewed with considerable skepticism.

Progesterone Supplement

Unfortunately there are a significant number of animals that have no identification problem, are pregnant at 20 to 30 days following mating, and yet are open when rechecked 45 to 60 days following mating. Likewise there are animals that repeatedly will carry a cria for 10- 10.5 months before delivering a premature baby. In these groups, progesterone therapy may be appropriate if all other known causes of abortion or premature birth have ruled out. Before any supplementation is considered, however, it is strongly recommended that owners carefully discuss their options with their veterinarian. If the decision is made to try progesterone supplementation, there are at least two options available to the owner. One product is an implant called Synchro-Mate-BTM. The product is marketed and has label clearance only for use in non-lactating cattle. The capsule is implanted under the skin and releases a synthetic progesterone-like compound, norgestament, for several weeks. The product is marketed as a means of synchronizing estrus in the cow so that multiple animals can be bred within a short period of time. Approximately nine days following placement of the capsule, it is removed. Most of the animals will show signs of estrus within a few days following capsule removal as the progesterone concentrations decline and estrogen production by the ovaries increases.

Although some owners have reported using the capsules in the Llama, there are several factors that an owner should consider. First, the product is not approved for use in the Llama or alpaca. If the animal develops problems as a result of using the product, the manufacturer is not responsible for handling the problem. A second problem is finding a suitable injection site. Since the capsule has to be removed, it must be in an accessible location such as the ear or in the hindquarters. Unfortunately, most Llamas do not like having their ears repeatedly grabbed and products injected under their skin. There is also a slight chance of local infections either when the capsule is implanted or removed. Finally, there is no solid information on the appropriate frequency of capsule implantation or if the therapy is effective. To further complicate the issue, the progesterone derivative in the capsule does not react with the standard progesterone assay so it is not possible to easily determine the proper dosage.

A second option is to inject the animal with progesterone on a regular schedule. Progesterone is very soluble in oils and fats and usually comes dissolved in an oil carrier. There is, however, no information available concerning the appropriate dosage or frequency for use in the Llama. Based on work in the horse, however, daily injections are probably necessary. There is also a longer lasting form of progesterone that has been used in horses. Unfortunately, it has a tendency to form a precipitate, can be very irritating, and is probably not a viable option for use in the Llama.

If the decision is made to provide supplemental progesterone to the chronic aborter animal or the dam with a history of premature births, the good news is that progesterone normally has a wide margin of safety. Unlike estradiol administration which can produce some very serious side effects, progesterone implants or injections are generally safe. While progesterone supplementation may be ineffective, unless very large dosages are used, it is also probably not going to hurt the animal.

Summary

The steroid hormone changes observed during pregnancy in the Llama are very similar to those changes seen in other domestic species and are probably controlled in a like manner. Although there has been substantial discussion concerning inadequate progesterone concentrations as a cause of abortions and premature deliveries in the Llama and alpaca, there has been no research in either species to support this view.

Acknowledgements

The author wishes to thank Commander Bud and Diddee Deacon, Llama Land, Turner, Oregon, for their tremendous cooperation and help in permitting sample collection from their animals. The author also wants to thank the Williamette Valley Llama Association and ILA whose financial support made the project possible and fellow faculty members and students at OSU for reviewing this manuscript.

Pregnancy Diagnosis in the Llama

by Brad Smith Oregon State University

Pregnancy is the key to a successful Llama operation, making the early and accurate diagnosis of pregnancy one of the most important concerns for the producer. This article will review some of the early physiologic changes associated with conception, discuss how some of these changes can be used in the diagnosis of pregnancy and outline some of the diagnostic choices available to the owner. Unfortunately, there is no one "best" method of pregnancy diagnosis, and this article will attempt to point out the strengths and weaknesses of each method.

Economics

With the escalating prices being paid for average quality females, not to mention superior animals, the financial health of many commercial operations is dependent on the animals having a high rate of reproduction. Under optimal conditions, a female should be able to carry to term one successful pregnancy per year. Unfortunately, theory and reality frequently clash, with many Llamas having significantly longer intervals between births. There are a variety of reasons for difficulties in conception and carrying a pregnancy to term including: uterine infections, damage to the reproductive tract, infertile males, anatomic abnormalities and a range of other health problems. Before any of these problems can be addressed, however, it is necessary to first determine if the animal is pregnant. The difference in economic loss to a producer who determines that an animal is not pregnant 120 days following breeding, versus 30 days post-breeding, is substantial.

Normal Reproductive Physiology

In order to understand the basis for the different methods of pregnancy diagnosis, a review of the normal reproductive physiology of the Llama is in order. The ovaries of the Llama are small (approximately 1/2 to 1 inch long) and shaped like almonds. Within the ovary are all the eggs the Llama will have during her lifetime. The vast majority of these eggs (primary follicles) will never develop, while a few will develop into more mature secondary follicles. A few of the secondary follicles will develop even further into mature Graafian follicles, fluid filled structures up to a quarter of an inch in diameter. The Graafian follicle contains the mature egg that can be fertilized following ovulation. If ovulation doesn't take place, the follicle will degenerate and be replaced by another follicle.

The Llama is similar to the cat, rabbit, ferret, mink and camel – all are induced ovulators. The breeding stimulus causes the release of a hormone from the pituitary, a gland at the base of the brain. This hormone (luteinizing hormone or LH), in turn, causes the mature follicle to rupture and release the egg into the oviduct, where it is fertilized. Following this release (ovulation), the follicle fills with blood, the cells of the follicle undergo a reorganization and become a temporary hormone secreting tissue, the corpus luteum or CL. The primary hormone produced by the corpus luteum is progesterone, the most important hormone during pregnancy. If progesterone production ceases, the animal will not be able to continue the pregnancy and will abort. Blood progesterone concentrations are normally very low, being measured in units of nanograms of material per milliliter. To put these concentrations in perspective, diluting one drop of food color in a swimming pool would produce a dye concentration of about one nanogram (ng) per milliliter (ml). Progesterone concentrations in the Llama vary between approximately 0.1 ng/ml (no CL) to 4-6 ng/ml (functional CL).

As the follicle becomes a corpus luteum, its appearance and composition changes. Whereas the mature follicle was fluid-filled and fairly soft, the CL is much firmer and usually projects somewhat above the surface of the ovary.

This difference in composition is an important factor in the diagnosis of pregnancy by rectal palpation.

Methods of Pregnancy Diagnosis

There are four methods of pregnancy diagnosis that will be discussed: a) serum progesterone, b) rectal palpation, c) ultrasound and d) use of the male. Each of these techniques has its advantages and limitations – and as previously mentioned, there is no one "best" method.

Serum Progesterone

Probably the most widely used method of pregnancy diagnosis is the measurement of blood progesterone concentrations. The technique involves the collection of a blood sample, separation of the red cells from the blood and sending the serum to a lab. The laboratory will be using a technique called radioimmunoassay (RIA) to measure the progesterone concentration in the sample. The technique involves the use of radioactively labeled materials and requires some very expensive analytical equipment.

Sample collection is usually done by your veterinarian who will separate the blood cells from the serum and send it in for analysis. It frequently takes between seven and ten days for sample collection, mail time, lab analysis and the reporting of results to the owner. In addition to the lab analysis expenses ($10 to $16 per sample), there will usually be additional charges by your veterinarian for the farm visit, sample processing and shipping.

Serum progesterone concentrations of greater than 1.0 ng/ml usually indicate pregnancy. Fortunately it is not difficult to differentiate pregnant and non-pregnant animals since most open (non-pregnant) animals will have progesterone concentrations of 0.1 to 0.4 ng/ml, while pregnant animals will have serum progesterone concentrations of 1.5 to 6 ng/ml. Occasionally, unfortunately, an animal will have a progesterone concentration between 0.6 and 1.0 ng/ml – the indeterminate range. These animals should be retested.

We have followed a large number of animals through pregnancy, and the absolute progesterone concentration (assuming it is above 1.0 ng/ml) appears to vary substantially between animals. We have had some animals with progesterone concentrations of 1.5 to 1.8 ng/ml, while others have had progesterone concentrations of 4.0 to 6.0 ng/ml throughout pregnancy. Above a certain minimum concentration, however, the absolute progesterone concentration does not appear to have any significant impact on the animals ability to carry the fetus to term. If you run multiple progesterone assays on your animal during pregnancy, do not be surprised if the concentrations vary substantially – up to 1.0 ng/ml difference between individual samples.

Increasingly, animals are being sold as pregnant based on blood progesterone concentrations. It is important to keep the following limitations in mind when using this information:

a) Because the animal had a high progesterone and was pregnant at the time of sample collection, it does not guarantee that the animal is STILL pregnant.

b) Occasionally an animal will have a functional CL but will not be pregnant. The underlying cause of this condition is only partially understood. Fortunately, this is a rare condition and does not substantially detract from the use of serum progesterone concentrations as a tool for pregnancy diagnosis.

The timing of sample collection for progesterone determinations is also important. Figure 2 illustrates the changes in progesterone production following ovulation. If an animal has ovulated, the CL will produce progesterone for a few days irrespective of whether or not the animal is pregnant. As a result, early sample collection will only tell you if the animal has ovulated, not if she is pregnant. If the animal is not pregnant, the CL will begin to regress after a week or so and progesterone production will decline. It also appears that there is substantial early embryonic death loss during the first few weeks following breeding. As a result of these variables 30 and 45 days after the removal of the male is usually a good time to collect a blood sample. Although samples can be collected earlier, there is also an increased probability of incorrectly calling an animal pregnant (progesterone concentration of greater than 1 ng/ml). If the lab reports progesterone concentrations of greater than I ng/ml in blood samples collected 30 days after breeding, the chances are very high the animal was pregnant at the time of sample collection.

Schematic representation serum progesterone concentrations in a Llama following a single breeding. Within a few days of breeding, the corpus luteum will be producing progesterone and preparing the uterus for the egg. If the animal has not conceived or the fertilized egg dies, the corpus luteum will "regress" or die (dashed line) and stop producing progesterone. Thirty days following removal of the male is usually a good time to collect a blood sample for progesterone measurements.

Rectal Palpation

Another widely used technique is rectal palpation. For this technique to be successful, good restraint is ABSOLUTELY ESSENTIAL A head gate, or some other means of minimizing the animal's ability to turn, is necessary. The veterinarian will put an obstetrics sleeve over his/her arm, lubricate it thoroughly and then very carefully insert it into the animal's rectum. Although it looks like a physical impossibility, with a little care some practice, and a bit of work, it is possible for your veterinarian to get his/her hand and forearm into the animal. The technique causes the animals remarkably little apparent stress and most animals adapt very readily to the technique.

The biggest advantage of rectal palpation is that it permits the veterinarian to feel the reproductive tract. The veterinarian can feel the ovaries (usually), noting the size, consistency and any ovarian structures. The cervix and uterus are palpated as well. If the animal is pregnant, the fetus can be felt within the uterus. The advantage of palpation is that it gives the veterinarian a great deal of information concerning the reproductive status of the animal. Another important advantage of rectal palpation is that the owner knows immediately if the animal is pregnant. If the animal is not pregnant, it allows the veterinarian to start doing a fertility evaluation without having to make a second visit. As with serum progesterone determinations, knowing when the male was removed is important. Although it is possible to diagnose pregnancies as early as 30 days post-breeding, 45 to 60 days post-breeding is a much easier and more reliable time for palpation.

The potential problems with palpation are:

a) Some animals will not stand still for palpation. It is virtually impossible to palpate a wild animal.

b) The technique can be difficult will some small animals.

e) Large hands make the technique difficult.

d) There is always the potential for tearing the rectum and the animal developing a case of peritonitis. The reality is that this is very rarely a problem, but it does exist and owners should be aware of the possibility.

e) Theoretically, palpation could also injure the fetus and cause an abortion. In other species, this is very rarely a problem.

Ultrasound

A relatively new technique being, used by some owners and veterinarians is diagnostic ultrasound. These units are technically called portable linear array diagnostic ultrasound units and cost between $10,000 and $20,000. The most important part of an ultrasound machine is the transducer unit, a combination of a transmitter and a receiver in a single package. The transducer is reasonably small, fits easily in the palm of the hand and can be inserted into the rectum. After fecal material has been removed from the rectum, the veterinarian puts on an obstetric sleeves, lubricates the arm and inserts it with the transducer into the rectum. The transducer unit sends out a high frequency wave that penetrates the tissue and then bounces back to the receiver, a different portion of the transducer. As the waves pass through soft tissue, bone, gas and fluid, the nature of the reflected waves change. It is this change in reflected waves that is shown on the monitor unit attached to the transducer by a cable.

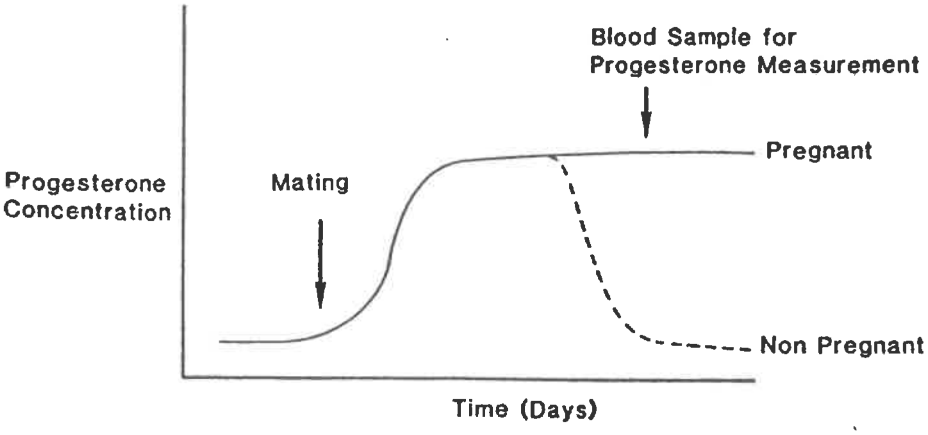
The advantage of using an ultrasound unit is that it permits a good visualization of the reproductive tract and sometimes the ovaries. If the fetus has developed sufficiently, it is possible to see the vertebrae, head and watch the fetal heart contract. Diagnostic ultrasound units are extremely helpful in the evaluation of reproductive problems.

It is not apparent, however, that diagnostic ultrasound offers any significant advantages over other techniques for routine pregnancy diagnosis. Unless the operator has had significant experience, the images can be difficult to interpret, and substantial skill is required to correctly place and direct the transducer. There is the same potential risk of a rectal tear that is associated with palpation, and due to the equipment costs, most veterinarians charge significantly more for ultrasound pregnancy diagnosis.

In addition to the use of intra-rectal ultra-

Table 1
Summary of Pregnancy Diagnosis

Test	Advantages	Disadvantages
a) Blood Progesterone	– accurate, minimum trauma to animal	– 7 to 10 days for result moderately expensive
b) Rectal Palpation	– accurate, rapid inexpensive	– potential for rectal tears, some trauma, requires technical expertise
c) Ultrasound	– reasonably accurate, rapid	– expensive, potential for rectal tears, some trauma, require technical expertise
d) Male	– inexpensive, rapid, reasonably accurate	– minimum, requires someone to take the time to move and watch the animals



Schematic representation of the serum progesterone concentrations in a llama following a single breeding. Within a few days of breeding, the corpus luteum will be producing progesterone and preparing the uterus for the egg. If the animal has not conceived or the fertilized egg dies, the corpus luteum will "regress" or die (dashed line) and stop producing progesterone. Thirty days following removal of the male is usually a good time to collect a blood sample for progesterone measurements.

sound, there has been interest in the use of external ultrasound for pregnancy diagnosis. This approach involves using the same equipment to diagnoise pregnancy by placing the transducer in the flank region and pointing it towards the uterus and ovaries. In general, this approach has not been very satisfactory. Some owners have also reported success using ultrasound diagnostic units in the pig. These units are substantially cheaper than the linear array units and function using a slightly different principle.

For the most part, the results have been unsatisfactory since it is very easy to get both false positive and negative results.

Typical ultrasound equipment used for the diagnosis of pregnancy. The transducer (black) is lubricated and carried into the rectum. The image is viewed on a video screen.

Male

One of the most satisfactory, and widely overlooked methods of pregnancy diagnosis, is the use of the male. By 30 days post-breeding, essentially all pregnant females will vigorously reject breeding efforts by a male that is introduced to the pasture. Most pregnant animals will run from the male, spit and refuse to be bred. Introducing a sexually mature male with good libido for 15 to 30 minutes to the female and watching their interaction will usually provide a very good indication of the female's pregnancy status. Unfortunately (or fortunately) all males were not created equal, and some overly aggressive males may succeed in getting a pregnant female to lie down and be mated. Watching and removing the male if the female is obviously not receptive will avoid this problem. The only drawback to this method is that it does take some time.

Summary

There are a varied of good techniques available for pregnancy diagnosis designed for use in the Llama. The relative merits and disadvantages of each technique are summarized in Table 1. Of these methods, using the male is the quickest, easiest and cheapest method available. It also is not 100% accurate. The owner who relies exclusively on the male should assume that a percentage of the females will be missed and will not be pregnant. From a practical point of view, using the male is a good initial screen and will adequately check most animals. This is a particularly good technique when you know your male and his behaviour pattern around open females.

When pregnancy status is not clear from the male's behaviour, or if the animal is being sold or getting ready for auction, then either a blood progesterone measurement or rectal palpation is appropriate. Although rectal palpation offers the ability to rapidly determine if an animal is pregnant, this method may not be acceptable to some buyers, necessitating a blood progesterone. There is also the potential for rectal tears. Again it must be emphasized that while rectal palpation is generally safe, it is absolutely essential that the animal be adequately restrained. The value and role of diagnostic ultrasound for routine pregnancy diagnosis is questionable. Although it is fun and interesting to be able to watch the developing fetus, the technique is generally more expensive than other methods, represents approximately the same risk as rectal palpation, may or may not be more accurate than other techniques and requires a high degree of technical competence to be effectively used.

COLOSTRUM

Immunoglobin Absorption in the Llama

by Brad Smith, D.V.M., PhD Oregon State University

The Llama is born with essentially no blood immunoglobulins (antibodies) making it susceptible to a wide range of bacterial and viral infections. To partially overcome this deficiency, the first milk from the dam (colostrum) is a highly concentrated mixture of immunoglobulins that provides the cria with temporary protection during the first 4 to 8 weeks of life. Unfortunately, many crias do not get sufficient colostrum and thus are susceptible to overwhelming infections by a wide range of common, normally non- pathogenic, organisms. Although some of these susceptible animals will survive with no apparent problems, others will become ill during the first few weeks of life and a portion of these will die. Crias that fail to receive sufficient immunoglobulins are referred to as "failure of passive transfer" (FPT) animals and will be the focus of this article.

Colostrum:

Shortly before birth, the mammary glands begin production of immunoglobulins (antibody). This immunoglobulin rich first milk is called colostrum and has a characteristic thick yellow appearance. While the total volume of colostrum is relatively low (<500 ml or 1 pint), the immunoglobulin concentration is extremely high.

Although only a few studies have specifically examined the composition of immunoglobulins in Llama colostrum, there is substantial information concerning the composition and function of colostrum in other species. As a result, the following discussion is based on information from both the Llama and alpaca as well as other species. Colostrum is composed of water (the largest percentage), fats and liquids, sugars (e.g., lactose), and various proteins (e.g., casein and immunoglobulins). There are at least 3 distinct forms of protein immunoglobulins (Ig) in colostrum, specifically IgG, IgM, and IgA in most species. The IgG and IgM forms are known to exist in the Llama, while the existence of IgA in the Llama is unknown but presumed to exist. The IgG fraction is sometimes further subdivided into subclasses, e.g., IgG1, IgG2, etc. Each of these immunoglobulins has a slightly different structure, function, and lifespan.

Although milk from all animals who have given birth recently contains some immunoglobulins, the highest Ig concentrations are in colostrum. Milk formed 48 hours after birth contains only a small fraction of the IgG concentrations found in colostrum. The practical importance of this decline is: a) milk collected >24 hours after birth does not contain substantial amounts of immunoglobulins and would not be a good source of IgG for colostrum deprived animals, and b) dams that have leaked a substantial volume of milk prior to delivery will have less IgG, IgM, and secretory IgA available for use by the cria.

Colostrum Absorption:

One of the unusual characteristics of essentially all newborn mammals is the permeability or "leakiness" of the small intestines during the first 24 hours of life. During this period, immunoglobulins in colostrum can be absorbed intact by the cria. For reasons that are not clearly understood, between 12 and 24 hours after birth the permeability of the intestines to large molecules such as immunoglobulins decreases significantly. In premature animals this change in intestinal permeability may begin even earlier than in full term crias. By 24 hours after birth, the small intestines in essentially all animals have "closed" and only very small molecules can be absorbed. After this period, immunoglobulins are digested like other proteins in the third compartment of the stomach. This relatively short period of "leakiness" points out the importance of colostrum absorption during the first 12 hours after birth.

Placental Types:

While colostrum is absolutely essential in the Llama, not all species are as dependent as the camelids for passive immunoglobulin protection. In some species, e.g., the human and mouse, the immunoglobulins diffuse across the placenta from the maternal to the fetal circulations prior to birth. While there are a variety of reasons why nursing is beneficial for the newborn human or rodent, youngsters of these species usually have adequate immunoglobulin concentrations without having to nurse. The primary reason for this is differences in placental types between the species. The Llama has a placenta that is very similar to that of the horse and pig with a total of 6 tissue layers separating the fetal and maternal blood supplies. In contrast, the human and mouse have only 3 tissue layers between the blood supplies. This difference in number of cell layers appears to be the primary factor regulating the diffusion of immunoglobulins from the maternal to the fetal circulation.

Normal Absorption of Colostrum:

With each nursing during the first 12- 24 hours of life, the cria will absorb more immunoglobulins and the blood Ig concentrations will increase (Figure 1). Although the Llama presumably has IgA in addition to IgG and IgM in its colostrum, probably only the IgG and IgM fractions are absorbed. The IgA likely stays in the intestinal tract and plays a role in local intestinal protection. Assuming that the IgM is metabolized in the Llama and other species in a similar manner, most of the IgM will be excreted by the kidneys into the urine within the first 5 to 10 days of life. In contrast, the IgG fraction will be present in significant concentrations for at least 4-8 weeks.

When discussing the rate of immunoglobulin loss, immmunologists usually speak in terms of biologic half lives. It appears that the half life of IgG in the alpaca (and presumably the Llama) is about 10 days. This means that every 10 days the animal will lose half of the IgGs that it absorbed. By 10 days of age the animal has 50% of the immunoglobulin concentration, 25% by 20 days (50% of 50%), 12% by 1 month, etc. (Figure 2). Although this may appear as a tremendous rate of loss, it is important to remember that the cria's own immune system is beginning to develop its IgG and IgM during the same period. The cria will be developing antibodies against the bacteria, viruses, etc. in its environment during this time. Colostrum is important in providing, temporary protection until the cria's immune system is fully functional and has had a chance to respond to organisms in its environment. It should be apparent, therefore, that within practical limits, the higher the initial IgG concentration from colostrum, the better.

Nursing Crias will usually be on their feet shortly after birth and start trying to nurse. Once the cria has found the teats, most will start nursing vigorously. Gently squeezing the teats to clear any waxy plugs, debris, etc. will help ensure good milk flow for the cria. A "milk mustache" and increasing weight are good indicators of successful nursing. Vigorous nursing activity followed by a quiet period are also good indicators of successful nursing. Constant nursing, switching from teat to teat, and not stopping to rest bet ween feedings are signs of unsuccessful nursing.

In contrast to the healthy cria, particular care and attention needs to be given to the weak or debilitated animal that fails to stand and start nursing since the intestines are able to absorb the immunoglobulins for only a short period of time after birth. If the cria has not been observed to nurse within 6 hours after birth, owner intervention is

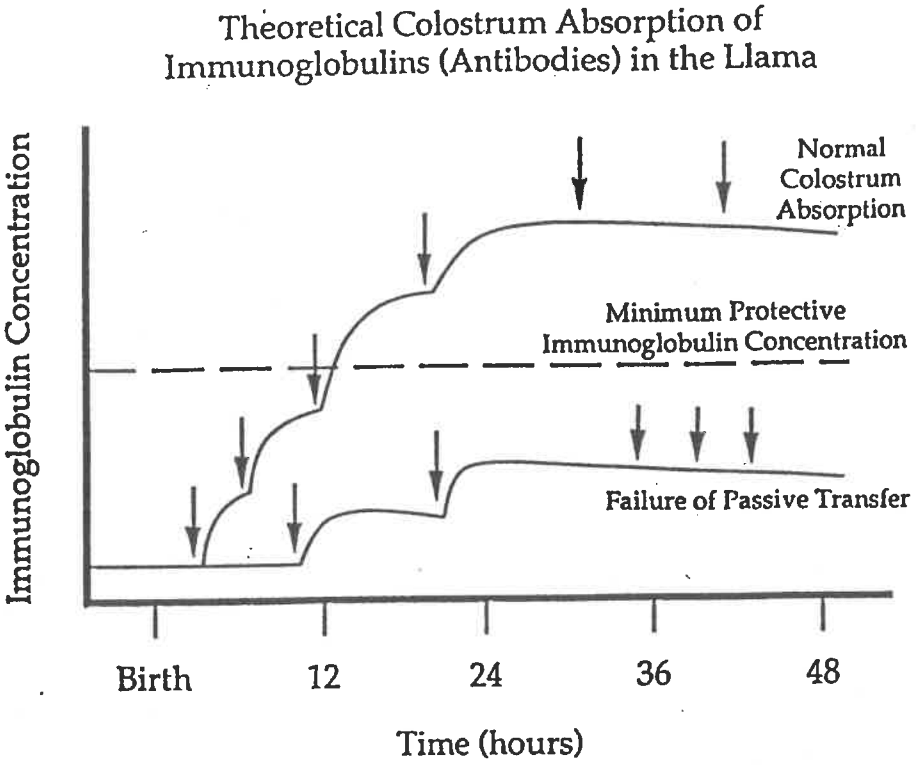
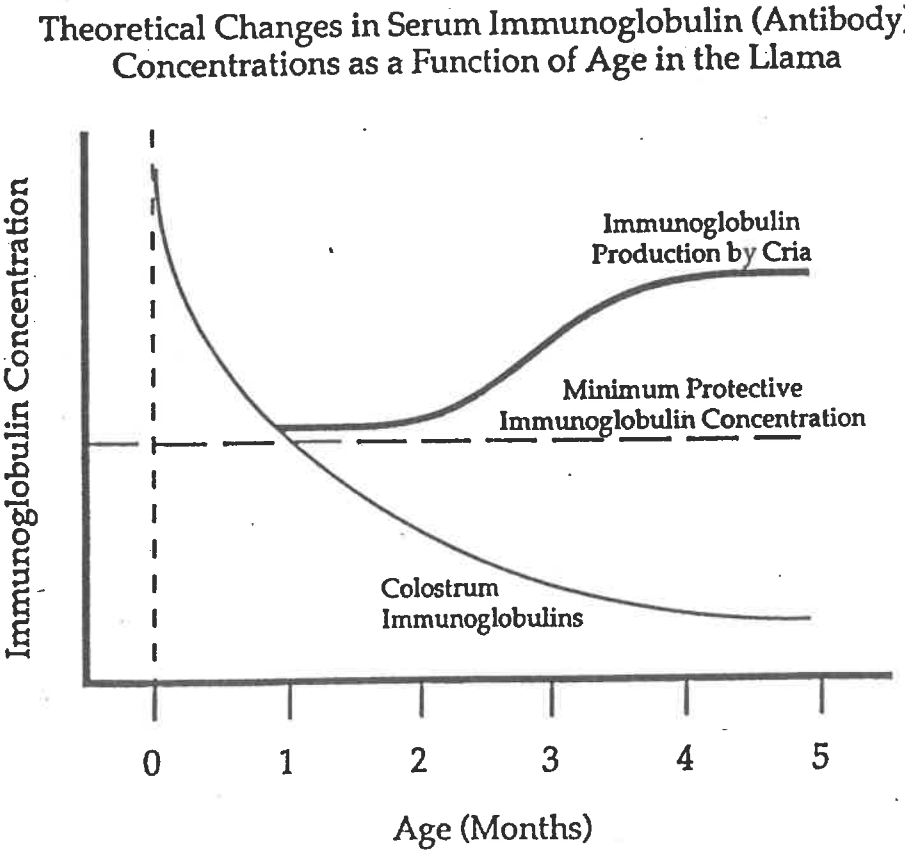


Figure 1: Theoretical changes in immunoglobulin (antibody) concentrations during the first 48 hours of life. The arrows represent times when the cria is nursing. Note that after approximately 24 hours, when the cria nurses there is no further increase in immunoglobulin concentrations. The upper line represents a cria with normal colostrum absorption while the lower animal is a FPT cria. The FPT cria did not nurse frequently enough during the period of intestinal permeability to reach minimum protective concentrations.

Figure 2: Theoretical changes in serum immunoglobulin concentrations during the first few months of life. Although the cria's immune system is functional at birth, it has not been stimulated to produce immunoglobulins. As the cria is exposed to different environmental bacteria, viruses and mycoplasma, etc., the animal's immune system begins to produce immunoglobulins. By 1-4 months of age, the cria's colostral immunoglobulins have declined to insignificant concentrations. In contrast, by 2-4 months of age, the cria's immune system is producing sufficient immunoglobulins for protection.



indicated (discussed later). Failure to get sufficient colostrum is of special concern for the premature animal. The combination of a weak cria that is unable to nurse vigorously and a dam with allow volume of colostrum and a lower than normal Ig concentration can spell disaster. With all crias, owner involvement in watching that the cria is on its feet and nursing during the first 12-24 hours of life, is of critical importance to the health of the animal.

Testing for Failure of Passive Immunoglobulin Transfer (FPT):

The following tests are available to determine if adequate immunoglobulins have been absorbed:

RID: The definitive test for the measurement of Igs in blood is usually considered to be the radial immunodiffusion test (RID). The test is run in the laboratory and measures the absolute concentrations of immunoglobulins in serum. The test depends on having antibodies (usually produced in rabbits) that specifically react with Llama immunoglobulins. Only recently has this test been developed and validated for use in the Llama. While the test is currently being used at Oregon State University, the Llama specific version of the test is not widely available elsewhere in North America. One advantage of this test is that it can be rapidly run and provides a more accurate estimation of IgG concentrations than do the other tests.

Electrophoresis:

A second test is "serum protein electrophoresis." A very small serum sample is placed on a special gel and an electric charge applied to it. The different proteins in the serum move according to their electrical charge, i.e., some to the positive and others to the negative poles. After a predetermined period of time, the electric charge is stopped and the proteins are stained and examined. While this approach provides a satisfactory estimation of IgG concentrations, it is slow, expensive, and requires a laboratory.

Total Serum Proteins:

A third approach is to measure the total serum protein concentration using a refractometer. After a blood sample has been collected and allowed to clot, the serum is removed and the protein concentration measured using a handheld refractometer. Although it has not been fully validated for use in the Llama, it appears that total serum protein concentrations of <5.0 g/dl are consistent with FPT, 5.0-6.0 g/dl are marginal and >6.0 g/dl may indicate sufficient IgG absorption. A good study on South American alpacas conducted at La Raya, Peru showed that mean serum protein concentrations in healthy crias increased from 4.7 g/dl prior to nursing to 8.0g/dl at 24 hours.

Turbidity Tests:

The turbidity test works by mixing serum samples with different concentrations of zinc sulfate or sodium sulfite and looking for a cloudiness or precipitation in the tubes. The tests are quick, easy, and give an indication of serum IgG concentration ranges, but have not been rigorously tested and evaluated for use in the Llama. Another frequently used test is the "Bova- S"TM test, a modification of the turbidity tests developed and validated for use in the cow. Although the accuracy and reliability of the test has not been adequately validated for use in the Llama, several clinicians and owners have reported success in using the test.

The absolute serum concentration of IgG necessary to provide adequate protection in the Llama is unknown (Figure 2). Work in the cow, horse, and other species suggest that a serum IgG concentration of <1000 mg/dl is probably sufficient, while a concentration of <400 mg IgG/dl is insufficient. Animals with IgG concentrations between 400 and 1000 mg/dl are in the equivocal range. Work in the alpaca suggests that the normal IgG concentrations may be higher. This research classifies crias with IgG concentrations of <900mg/dl as FPT, 900- 1500mg/dl as marginal, and >1500 mg IgG/dl as adequate immunoglobulin transfer. Mean serum IgG concentrations in healthy animals at 24 hours was 3010 mg/dl. The Triple J Ranch in Washington has done similar work in the Llama and based on results from 10 animals, reported mean IgG concentrations of 1367 mg/dl. This disparity of results points out the need for making decisions concerning possible plasma transfusions on more than just IgG concentrations. The general health, activity, and attitude of the cria have to be considered in addition to just IgG concentrations of animals that fall into the marginal range.

It is important to remember that these concentrations are not written in stone. Relatively little is known about The immune system of the Llama, and some of these values are extrapolated from work in other species. As our understanding of the Llama a immune system develops, these values may change. When evaluating a possible FPT animal, it is also important to consider more than just the test results. Decisions concerning possible treatments should be made in conjunction with your veterinarian after evaluating the overall condition and activity of the animal as well as the lab results.

Colostrum Replacement and Supplementation:

If it is suspected that the cria has not received sufficient colostrum, the owner's options will be largely dictated by time. As a rule of thumb, if the cria is:

– < 12 hours old – Use colostrum – 12 – 24 hours old – Colostrum and perhaps plasma transfusion later – >24 hours – probably plasma transfusion

The decision to do a plasma transfusion is a major medical decision that should only be made in conjunction with your veterinarian and will be discussed later. In contrast, giving the cria supplemental colostrum is straight-forward and can easily be done on farm by the owners.

There are two types of colostrum for use in the Llama: Llama colostrum and everything else. Llama colostrum will always be better than other types of colostrum since the dam will have developed antibodies against the specific organisms found in her environment that affect Llamas. While IgGs from another species are considerably better than nothing, they are not as effective as IgGs from a Llama.

Sometimes the dam will not permit the neonate to nurse, a problem that appears to be more common with first time mothers. Gentle restraint of the dam may help the cria start nursing. Other times, it may be necessary to manual milk out as much of the colostrum as possible. Most owners have noted that milking Llamas is at best difficult and can sometimes be an impossible undertaking. Assume that even if you are successful in collecting some colostrum from the dam, it is unlikely that you are as efficient as the cria in milking the dam. While feeding the colostrum to the cria is beneficial, work under the assumption that the cria is a potential FPT animal until proven otherwise.

If the cria's dam has died, refused to let it nurse, or had no milk, the cria needs supplemental colostrum. While it has been suggested that owners keep a Llama colostrum bank in their freezer, this is usually impractical. It should also be remembered that any colostrum collected and stored is that much less colostrum available for her current cria.

If Llama colostrum is the first choice, everything else is a second choice. While some producers swear by goat colostrum, others will only use cow colostrum. In either case, when buying colostrum from a local producer, it is important to make sure that the milk is from the first milking after birth. Milk collected during the second to fourth day after birth on commercial cow and dairy goat herds is normally referred to as colostrum and discarded. Only the very first milking, however, has high immunoglobulin concentrations and should be used for the Llamas.

The choice of cow versus goat colostrum is not clear cut. It has been suggested that since goat milk may be more similar to Llama milk than cow milk, that goat colostrum should be used. Likewise, it has also been suggested that since the goat and Llama are affected by some of the same pathogens, the goat should be a better source of colostrum. Based on work currently underway in our laboratory, it is not clear that either the sheep or the cow is inherently a better source of antibodies for the Llama. A practical problem with the use of goat colostrum is that commercial dairy goat herds can be difficult to find. Extreme care should be used in collecting colostrum from backyard dairy goat operations. Some veterinarians have indicated that Salmonella, a serious intestinal bacteria, is probably more common in small dairy herds with poor sanitation than in large commercial cow dairies. There have also been repeated questions concerning the possibility of the transmission of CAE (caprine arthritis encephalitis) virus from the goat to the Llama. The disease is a major problem for the goat industry and the question of transmission to the Llama has not been adequately resolved. Cow colostrum is probably a more reliable source of antibodies for the Llama. The colostrum should be collected from a Grade A dairy, divided into small containers, and frozen. Remember: the first milking contains the highest Ig concentrations. Colostrum can be stored in a variety of ways including ice cube trays, small bottles, and ZipLockTM freezer bags. The functional shelf life of colostrum is unknown but should be >1 year if the colostrum has not been defrosted. Although it is probably still fine, colostrum should be replaced after a year to insure its potency. When the colostrum is needed, thaw it in warm water to body temperature. DO NOT THAW THE COLOSTRUM IN THE MICROWAVE, the microwave can produce local hot spots that will destroy the immunoglobulins.

Another source of colostrum is a commercial cow product called ColostrxTM, a freeze-dried colostrum. No studies have critically evaluated the safety and effectiveness of this product in the Llama. The available information concerning its use in the Llama is anecdotal and has included owners and veterinarians who have been happy with the product and others who feel that it has contributed to the death of their animal. Some owners have reported 3 problems with bloat and diarrhea an have discontinued its use. Until the product has been more fully evaluated, it should be used with care.

The cria can be fed by either intubation or from a bottle. There are proponents of both approaches and it is not apparent that one technique is clearly superior. If the baby is weak and/or has a poor suckling reflex, intubation with a 10-13mm tube works well. The tubes can be obtained from your veterinarian, a feed supply house, or livestock supply catalog. Placement of the tubes can also engendered a fair degree of controversy with some advocating advancing the tube down the esophagus only as far as the junction of the neck and chest, others into the mid-chest region, and others into the first compartment of the stomach.

The argument for inserting the tube only to the junction of the neck and chest is that the milk in the esophagus encourages the rumen to change shape and funnel milk directly into the third compartment of the stomach. The risk with this approach is that the further up the esophagus milk is given, the greater possibility of the cria regurgitating and aspirating the milk. Pushing the tip of the feeding tube into the first compartment will ensure that the milk is in the rumen and minimize the possibility of regurgitation and aspiration. The problem is that in many animals, the milk will stay in the first compartment and ferment. Fermentation destroys the immunoglobulins and can cause other problems. This appears to be a particular problem in cold (hypothermic) animals. Regardless of tube placement cold animals should be warmed before feeding. An approach successfully used by still other owners is to pass the feeding tube part way into the chest cavity. If the tube has been accidentally inserted into the trachea, the animal will usually gag and cough when the tube reaches the lungs. In contrast, if the tube is in the trachea and only passed down to the junction of the chest and neck the animal will not necessarily gag. With any animal regardless of where the tip of the tube ends, it is ABSOLUTELY ESSENTIAL that the owner feel the tube as it passes down the esophagus. DON'T ADMINISTER ANYTHING IF YOU ARE NOT ABSOLUTELY SURE OF THE TUBE PLACEMENT. Once the tube is placed, give a small volume of colostrum (1-2 oz). If no coughing or gaging occurs, give the remainder of the colostrum.

The volume of colostrum that the cria needs will vary according to the IgG concentration in the first milk. As a general rule, there is no such thing as a cria getting too much colostrum. While a cria can't reasonably get too much IgG and IgM in the colostrum, it can occasionally get too large a volume of milk and have problems with diarrhea. This further points out the importance of getting the Ig rich first milk in general, a cria should get 6 to 10% of its bodyweight in milk during the first 24 hours. Since the volume of the cria's stomach is small at birth, smaller more 3 frequent feedings are better than fewer larger feedings. Four ounces of colastrum for a 25 pound cria would be a good starting point that can be adjusted up or down depending on the baby's appetite. Feedings should be repeated every 2-3 hours for the first 24 hours.

Since getting sufficient cow colostrum is usually not a problem, feeding colostrum for the first 48 to 72 hours should be considered. Although only minimal quantities of immunoglobulins will be absorbed after 24 hours, the colostrum is a good source of nutrition.

There is also "lactogenic immunoglobulins," primarily secretory IgA, in the colostrum that may be beneficial to the Llama. Although the IgA is not absorbed, in other species it provides additional local protection in the intestines. While the secretory IgA concentrations in cow's milk are lower than in some other species, it still may serve a local protective role in the Llama.

Plasma Transfusions:

If it has been established that the cria did not get sufficient colostrum, a plasma transfusion should be considered. This procedure should be done by your veterinarian and involves collection of blood into a sterile bag containing an anticoagulant. After the red cell have been separated, the plasma is infused into the jugular vein via a catheter. The volume, rate of infusion, and timing will vary according to the clinical condition of the animal.

Summary and Recommendations:

Once a well baby check has been completed (Llamas, Volume 3, #7, 35-43,1989), the most important considerations during the next 24 hours are that the baby gets sufficient colostrum and that the dam and cria bond. The dam's teats should be squeezed to remove any waxy material or foreign material. The cria should be Watched to confirm that he/she is up and vigorously nursing. If the dam dies, rejects the baby, or has no milk, the cria should receive 6-10% of its body weight as colostrum the first 24 hours of life divided into small feedings at 2-3 hour intervals. Both cow and goat colostrum have been successfully used. If it is uncertain that the cria has received sufficient colostrum, blood immunoglobulin concentrations should be measured. By 24 hours, the intestines have "closed" and a plasma transfusion will have to be considered if the animal has a failure of passive transfer.

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Pasture Management for the Llama Owner Part 1

by Drs. Brad Smith and Pete Ballerstedt College of Vetinary Medicine Oregan State University

I would like to suggest that Llama operations are a bit like the national debt – no matter how hard you try – they always seem to get larger. It is amazing the number of farms that started with one pair of animals. In time, two begat three. Not wanting to line-breed father and daughter, a new fancier male was purchased. To justify the money spent for the new male, additional females were purchased, and before long the original pair had grown into a herd of 15 to 20 animals. Unfortunately, the two acres of pasture that provided more than sufficient space for the original pair didn't grow at the same rate. Originally the pasture was sufficient to provide essentially all the forage the animals needed, now, with 15 animals sharing the same space, the pasture more closely resembles a putting green and is capable of providing only a fraction of the animals' nutritional needs.

Short of purchasing a larger farm or reducing herd size, there are several practical approaches a Llama owner can take to maximize the forage produced in the available area. This two part article will discuss different concepts of pasture management, techniques for improving the quality of existing pastures and some simple methods for maximizing forage production.

If someone calls you and asks, "How do I get to your place?," your first question will be "Where are you now?" It is equally important in managing a farm to first take stock of your available resources and the to define your goals and objectives. These steps are especially important if you are contemplating significant changes in your farm or management practices. Although the ultimate objective for most farms is to maximize forage production, it is also important to remember that there are many ways to reach the same end point. Many of your decisions will ultimately have to be based on how much time, effort and money you want to commit to changing your operation and how rapidly you want to see results.

Resources

The first step in pasture management is to make an objective assessment of the farm's resources. There are four major types of resources to be examined: fixed, semi-fixed, changeable and personal. Fixed resources, such as soil type, topography and acreage are givens and relatively unchangeable. Semi-fixed resources, such as water supply, existing fences and forage base, can be changed, but usually at some cost. Changeable resources, such as forage type, temporary fencing and animal numbers are your most flexible resources. These factors can be easily manipulated and are relatively inexpensive. The final class, personal resources, is finances, availability of labor and on-hand supplies. These resources are obviously unique for each farm. These factors are important to consider in developing your plans since the most carefully planned projects are of no value if you don't have the time or finances to execute them.

Soils.

Soil type and class, fixed resources, . will largely dictate what types of forages can be grown on the farm. This information can usually be obtained from your local office of the Soil Conservation Service. (Check the telephone book under government services). The Service may also be able to supply you with an aerial photograph of your farm. The photographs can be a useful tool in helping map your farm and planning changes in fencing, watering facilities, etc. Additional information on your soil can be obtained by slowly walking your pastures.

Soil Sampling

While examining your pastures, you should collect one or more soil samples to determine your fertilizer requirements. A soil probe will be required. You can purchase one through most farm supply catalogues, or alternately, you may be able to borrow one from your local county extension office. Your local extension office will also have literature describing the sampling procedure and be able to tell you what information is needed by local soil testing labs. If your pastures contain areas which differ in terms of slope, drainage or previous management, then plan to sample each area separately. One common approach when using the soil probe is to collect approximately 20 random, six-inch-long soil cores from each sampling area. Place the soil cores in a clean bucket as you collect them. When you have finished sampling an area, mix the soil well and fill the sample container provided by the soil testing laboratory. A standard soil test will determine the pH (acidity), phosphorous (P) and potassium (K) concentrations. The cost of analyzing a soil sample usually varies between $5 and $20 per sample. Nitrogen content of the soil is not routinely determined since numerous factors (e.g, soil moisture and type, sample handling and processing, e.g.) can dramatically alter the results. The working assumption is that all pastures need additional nitrogen for optimal forage production. This nitrogen can be supplied either by the growing legumes (plants that add nitrogen to the soil such as alfalfa and clover) or by using a chemical fertilizer.

If you tell the laboratory what grasses or legumes you are growing (or planning to introduce), the test results will often include a recommendation for lime, nitrogen, phosphorous and potassium fertilization. In Addition to routine soil analysis for pH, phosphorous and potassium, a request for other tests is appropriate in some parts of the country. For example, portions of the north-west and central United States may be deficient in sulphur. Your local extension agent can suggest which minerals are likely to be deficient in your region of the country. The soil testing lab can also provide valuable information concerning different types of fertilizers to correct soil deficiencies.

Walking the Fields

Let's assume that your farm has fertile, well-drained soils and lies on fairly level ground. The boundary fences are in good shape, and the farm has a major water source. Walk through your pastures and examine the stands of grass and clover you find. As you walk, ask yourself:

Is most of the ground covered with plants or is it bare a large amount of bare ground Are moss of the plants grasses and clovers, or are there large sections of of weeds? Are there any poisonous weeds? Are there areas with poor drainage?

Bare spots are of concern since they are not producing forage and provide an opening for weedy plants to invade. This is a particularly important consideration in regions of moderate to high rainfall (>35 inches of rain per year) or areas where the pastures are irrigated during the summer.

Identifying poisonous plants can sometimes be a tricky business; your local county extension office is an excellent source of information if you are uncertain about the identity of some of the specimens. Further complicating the issue, many toxic plants are regional in their distribution, so you need to be aware of which plants in particular to watch for in your area. The Extension Service can also usually provide information concerning the identification of non-toxic grasses and plants in the field. If poisonous plants are found, they must be removed from the pasture or your animals need to be kept out of the area infested with these plants. Assuming that the weeds in your field are not poisonous and occupy less than about 20% of the pasture, you should be able to live with them. In fact many "weeds" can be nutritious and palatable if they are grazed in an immature growth stage.

There is at least one more observation you should make while walking over your pastures.

Is the pasture evenly grazed or are there distinct patches of underground and overgrazed pasture?

This patchy grazing pattern usually represents poor forage utilization, and can be corrected by changing grazing management. These changes (to be discussed in Part II of the article) include division of the fields into smaller pastures, frequent rotation of animals between fields and changing the stocking density.

Pasture vs. Turf

Once an assessment of resources has been completed, the next question that needs to be addressed is "Do I want a pasture or a lawn (turf)?" The question is important since the management approaches will be different. If the animals sre largely fed from bunkers and the field is primarily used as an exercise area, the owner should consider treating the field primarily as turf (i.e., a large lawn). Although the animals will still get some nutrition from grazing, most of their energy and protein will be provided by the hay and any supplement being supplied.

In contrast, if the field is to be used primarily for forage, then the approach needs to be one of pasture management.

In many medium-sized farms, it may be appropriate to manage some fields as turf and others as pasture. For example, it may be desirable to manage the pasture adjacent to the road or in other high visibility areas as turf. The goal for this field is to produce a smooth, closely cut grass that will help show off the animals. In contrast, it may be desirable to manage the back field(s) as pasture with the intent of maximizing feed production and minimizing the amount of forage that has to be purchased.

Conclusions

The first step in pasture management is to make a critical evaluation of available resources. The assessment should include a realistic appraisal of how much space is available, how efficiently the space is being utilized and whether the available space could be increased by pasture drainage, removal of debris, etc. Nutrient availability is determined with a soil test. The fields should be walked and forage composition and coverage noted. Finally an assessmept should be made of fences, on-farm supplies and financial resources.

The second step involves defining your objectives for the farm. One of the earliest decisions involve whether to maintain the fields as turf, pasture or a combination of both. A second decision relates to how rapidly changes will be made. Some changes, e.g., fertilization, are rapid but of short duration while others, e.g., introducing more legumes, are slower, but more long term in effect.

Part II of this atticle will address specific changes to improve the quality of the pastures. These changes will include weed control, overseeding, fertilization and control of stocking density and pasture rotation.

Pasture Management for the Llama Owner Part II

by Doctor Brad Smith and Pete Ballerstedt College of Veterinary Medicine, Oregon State University.

Most llama farms have inadequate pasture space for the number of animals they are trying to feed. Part I of this article (Llamas, Vol. 3, No. 2, pg. 77, March/April 1980) outlined some of the initial steps that can be taken to increase forage production from the available space. These are: making a realistic assessment of available resources and defining your objective for the farm. This article will focus on the next steps: development of a management plan, correction of the problem(s), and finally, maintenance of a high level of forage production.

Management Plan

Once you have a good feel for the composition of your fields and decisions have been made concerning their usage (turf or pasture), a plan can be developed. Only rarely will fields be in such poor condition that it is necessary to completely start over. This drastic approach involves disking under the entire field, grading as necessary, fertilizing, smoothing and reseeding. This is a time consuming, expensive and often unnecessary procedure. In contrast, many fields can be improved by a program of fertilization, overseeding, weed control and grazing management.

Fertilizing

If in your initial evaluation nutrient insufficiency was identified as a problem, application of the recommended amount of fertilizer is the cheapest treatment for poor forage production. A long term approach to improving soil fertility involves plant in clovers and other legumes (such as alfalfa). These plants are desirable in a pasture because of their unique ability to contribute nitrogen to the pasture system. This group of plants has the ability to convert atmospheric nitrogen into organic nitrogen (nitrogen fixation) which can then be used by other plants, substantially improving the fertility of a field. If the legume content of the pasture is low (less than one third of the pasture plants) or if environmental conditions restrict the growth of the legumes, the use of nitrogen fertilizer is appropriate. Forty to fifty pounds of nitrogen per acre per application is usually adequate. If no other changes are made to the field (e.g., increasing the percent of legumes in the field), plan on applying 120 to 150 pounds of nitrogen per acre per year. Divide the nitrogen into three or four applications. In most regions of the country, fertilizing in early spring, again later in the spring at about the time of hay harvest and finally in the late summer or early fall will usually be sufficient. These are only guidelines, however, and the ideal interval between fertilizing, will vary according to soil type, the amount of rainfall, the rate of plant utilization and weather conditions. Some common nitrogen fertilizers are ammonium sulfate, ammonium nitrate, diammonium phosphate and urea. Some fertilizers contain nitrogen (N), phosphorus (P) and potassium (K). These materials may be referred to as a "complete" fertilizer. Regardless of what the fertilizer is called, it will be labeled with a series of numbers, for example 10-20-20. These numbers represent the percentage of N, P205 and K20 in the fertilizer. In this example, 100 Pounds of 10-20-20 or would supply 10 pounds of N,20 pounds of P2O5 and 20 pounds of K20. This information is valuable to you in two ways. First you can determine the amount of fertilizer you will need to apply to achieve a desired application rate of a particular nutrient. Continuing with our example, if you wanted to apply 40 pounds of N per acre (A), you would need to apply 400 pounds of 10-20-20 per acre: (40 pounds N/A) X (100 pounds of 10-20-20 / 10 pounds of N) = 400 pounds of 10-20-20/A

Secondly you can use this information to 'comparison shop" for fertilizer. For example, let's assume that 10-20-20 costs $6.90/50 pounds and that urea (46-0-0) costs $8.50/50 pounds. Clearly 50 pounds of urea costs more than 50 pounds of 10-20-20, but which is the best N buy? A pound of N from 10-20-20 costs $1.38:

($13.80 pounds of 10-20-20) X (100 pounds of 10-20-20/10 pounds N) $1.38/pounds N while a pound of N from urea will cost $0.37.

(S17.00/100 pounds urea) X (100 pounds urea/46 pounds N) = $0.37/ pounds N.

If the only nutrient needed by the field is nitrogen, urea is the most cost effective way to correct the deficiency. There are a variety of methods for applying fertilizers. For small pastures (<1/2 acre) a cyclone-type seeder may be the perfect tool. You carry the tool across the pasture while turning a hand crank to broadcast fertilizer or seed. For larger areas, you may want to consider the purchase of a pull-type fertilizer spreader. There are a variety of models available and your choice will be influenced by the size of your tractor (or ATV) and your farm. Some fertilizer dealers offer an application service if your purchase is large enough, your farm is within their delivery area and the topography of your farm permits the use of their equipment. It never hurts to ask.

Overseeding

Overseeding can be used to plant adapted, productive forage species. Overseeding will help fill in bare spots and can change the forage composition of a field. The easiest and cheapest method is usually to broadcast seed over the pasture during early spring or early fall depending upon your location. Successful overseeding will depend upon two major factors – obtaining good seed soil contact and limiting the competition between the existing pasture plants and the new seedlings. Prior to overseeding, the pasture should be mowed or closely grazed (<2 inches).A pasture drag or a harrow of some kind should be employed prior to broadcasting seed and fertilizer. This will open the sod and rough up the soil surface, improving the chances of success. An additional dragging after the seed is broadcast will be helpful.

There are two ways to reduce plant competition – by grazing and with chemical suppression. If grazing is employed, it is vital that the animals be removed from the pasture once the new seedlings emerge and that the animals not be permitted to graze until the plants have grown enough of a root system to prevent them from being pulled out of the ground during grazing. A good rule of thumb is that animals should not be permitted to graze for four to five weeks after overseeding a field. If you have the equipment or can find a local farmer willing to help you, the application of paraquat or glyphosate prior to seeding is the most effective method of suppressing the existing pasture plants and allowing the new seedlings a chance to become established. Be sure to read all labels, and follow all product instructions carefully. Further information concerning the safe use of these or any other pesticides can be obtained from your local county extension office.

There are a number of pieces of equipment which are designed to plant seed into an existing sod. It may be possible to arrange for someone to do this for you on a custom basis. Regardless of how the seeding is done, it is vital that you select a well adapted species and variety. For example, typical forage grasses in humid southeastern regions of the U.S. will typically include Bermudagrass, tall fescue and orchardgrass. Once again, your county extension agent or farm supply house is a good source of information.

Weed Control

There are a number of herbicides available that control a long list of weeds. Some advice will be needed to make the proper selection, and proper caution should be exercised in the application of the product you choose. Some of these herbicides will persist in the environment for a period of time, so care needs to be taken that overspraying, run off and contamination are minimized. Also keep in mind that if you kill the weeds that are present without reintroducing a desirable species and correcting the problem that produced the opening for the weed in the first place, you will likely be wasting time and money. Remember weeds in a pasture are most often a symptom of other problems. Identify and solve the problem.

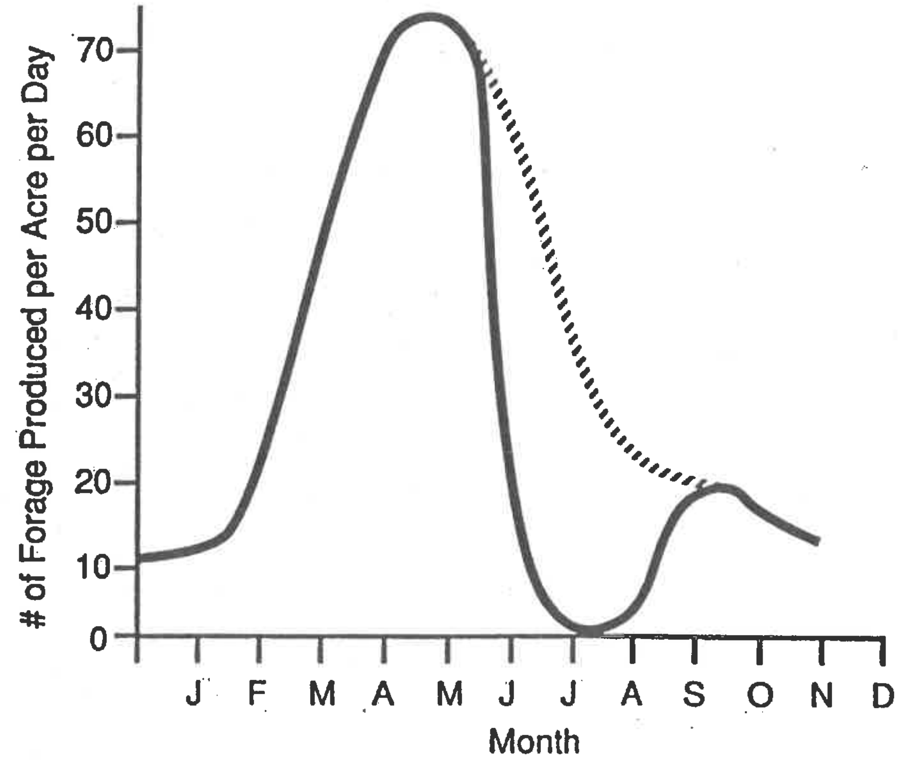
Grazing Management

Pasture rotation can resolve many problems of overgrazing. This can be accomplished by subdividing your pastures with permanent fencing, using temporary fencing to create smaller paddocks, or, if you have only a few animals, a tether. Regardless of how this is accomplished, control of grazing can yield benefits in terms of forage production and utilization.

Pasture Growth

In order to maximize forage production from your pasture it is important to consider how pastures grow. The forage production from a hypothetical cool season grass-based pasture is shown in Figure 1. During the winter months, feed productions will be very low, or in severe climates, stop completely. As the weather warms during the spring, grass growth increases rapidly. Nutrient availability in the soil, soil temperature and the amount of sunlight are the major factors limiting pasture growth at this time. In non-irrigated fields, water and high temperature become the limiting factors in forage production for cool season adapted grasses during the summer. There is usually a small rise in forage production during the fall when the weather cools and water becomes more available. The dashed line in Figure 1 represents the theoretical forage that could be produced by the same field if either flood or sprinkler irrigations used during the summer months. It is important to remember, however, that although most fields will follow this general pattern, the absolute values and the shape of the curve will vary somewhat depending upon your location. For example, in warm wet climates the winter production of forage will be higher, while the duration of summer forage will be shorter in cold northern climates. The important point is that feed production per acre will vary continuously throughout the year. If you are not prepared to manipulate the number of animals per acre, pasture size or to make hay out of the surplus growth during the spring, then you should be prepared to mow your pastures during the spring flush period. The reason for this will be explained later.

Another important concept in pasture management is how pasture growth is related to the intensity of grazing. Pastures do not grow at a constant rate. For example, it does not take the same length of time for a pasture to grow from one to two inches as it does for the same pasture to grow from six to seven inches. When the grass is either very short, or alternately very long, the rate



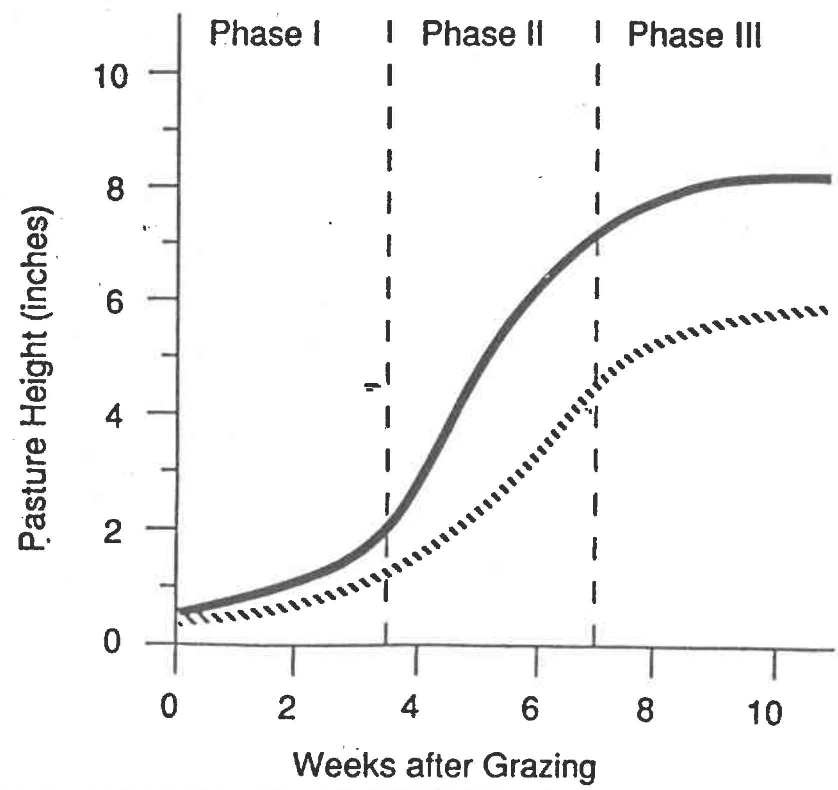


Figure 1: (above) Pasture production curve representing pounds of dry matter (DM) produced per day throughout the year from a "generic" field. The magnitude of the winter drop in forage production will vary according to the local climate. The dashed line represents the theoretical forage production from the same field if flood or sprinkler irrigation is used during the summer months.

Figure 2: (below) Average pasture height as a function of time in weeks following grazing. Note that when pastures are grazed closely (<2 inches), regrowth is much slower than when fields are grazed less severely before being rested. The solid line represents the theoretical growth rate seen during late spring while the dashed line represents pasture growth during early spring or late summer. The length of each growth phase will also vary somewhat during the year.

of growth declines. This relationship is seen in Figure 2 in which the grass height is related to how long it has been since the field was grazed. The practical importance of this information is that under ideal conditions, a field should not be grazed to less that two inches of height or let grow taller than about eight to ten inches. If a pasture reaches eight to ten inches in height, then those pastures should be set aside for a later hay crop. If hay making is not planned, then mowing should be planned so that pasture height can be maintained at or below six to eight inches. When animals are allowed to overgraze a field, it takes proportionately much longer for the field to regrow than if the field had been less intensely grazed. If continually overgrazed, a plant will weaken and eventually die.

One of the most effective ways to avoid overgrazing is to divide pastures into smaller fields and then rotate the animals onto the various fields for a short period of time. In an ideal world, it would be great to have sufficient pastures to permit heavy grazing for two to three days and them move the animals onto a fresh field. After the first pasture has had four to six weeks to recover, animals would again be allowed to graze for two to three days. Unfortunately theory and reality frequently clash, and few farms have the luxury of having 15 to 20 small fields. Even if it is only possible to divide the pastures into four to five smaller fields, by grazing one pasture heavily and then moving the animals, the total amount of forage produced on the farm will be increased. There are numerous ways that a field can be divided. The options range from permanent fencing (see Llamas magazine, Vol. 2, No. 4. Pg. 25, July/August 1988) to the use of temporary electric fences. With permanent fences it is easy to shift animals between fields. The disadvantage is that they are relatively expensive and can make the changing of sprinkler systems and tractor work somewhat more difficult. Although electric fences are an inexpensive and effective manner by which to divide fields, they require more maintenance and time to move as pasture changes are made.

Turf Management

The term "turf management" is not meant to imply the type of management that would result in a front lawn or golf course type of appearance. This term implies that pastures managed in this manner will not be primarily managed with grazing animals, but rather through a program of mowing, fertilizing and overseeding. Maximum pasture height should be between four and six inches. Mowing equipment will be needed and its size will be determined by the size of the pastures being managed. The busiest mowing season will be during the spring for the reasons discussed previously. Fertilization will be similar to "pasture management" with the exception of nitrogen. When it Comes to nitrogen, the adage of "fertilize as you utilize" applies. If you don't need more feed, don't apply nitrogen. Otherwise you will simply end up mowing more frequently. Grasses such as Kentucky bluegrass and bentgrass, if adapted to your area, may be valuable plants in this type of management plan. Due to their growth habits and spreading nature, they form a dense turf that can withstand close grazing. The periodic removal of manure piles will decrease parasite build up on the pasture and give the pasture a more even appearance.

Conclusions

I would like to propose the first law of Llama ownership:

"Llama herds increase in size irrespective of all efforts to control the breed size."

Given that all Llama herds seem to inexorably grow, most Llama operations are sooner or later faced with the dilemma of inadequate space for the number of available animals. Short of either reducing the number of animals in the herds or buying a larger farm, the most practical way to minimize the amount of purchased forage is to get the most feed out of the available space.

The first step is to evaluate what resources are available. This evaluation should include space availability, soil type, nutrient content of the soil, types of plant coverage and the depth of the pocketbook. The second step involves setting goals (e.g., pasture or turf, increasing forage production, etc.) for your operation and then determining what changes need to be instituted. These changes may include overseeding thin or bare areas, addition of new types of grasses, elimination of weeds and poisonous plants and changes in drainage or irrigation. Related to setting your goals, you need to decide if you want to go for a quick fix (e.g., adding nitrogen to the field), long term (e.g, addition of legumes) or a combination of both. Once the pasture has been improved, the final and most easily overlooked step is pasture maintenance. Pasture rotation, fertilizations necessary, adequate irrigation and avoiding overgrazing will all contribute to providing the highest long term production of forage and will minimize the number of times you need to visit the folks at your local food stores.

It is important to remember, how-ever, that there are practical limits to how much forage can be produced in a given area. If the animal density is two high, the grass never has an adequate chance to develop and large bare spots should be anticipated, Under these conditions, consider selling of part of the herd or think about buying a part of that adjacent farm.

About the Co-Author

Pete Ballerstedt, the co-author of Pasture Management for the Llama Owners, Parts I and II was born and raised in Philadelphia. After receiving his degrees from the Universities of Georgia and Kentucky, he joined the faculty of Oregon State University. As the forage specialist, he has the responsibility of covering hay, pasture and silage crops throughout Oregon. His special interest is in the area of pasture management and utilization.

Meningeal Worm Infections in the Llama

by Lora Rickard, MS and Brad Smith, DVM PhD, Oregon State University

One of the unwritten joys of owning Llama is that there is always something to worry about. If it isn't heat stress, it's the threat of imported foot and mouth disease, a dystocia in your best female, or liver flukes. To this list should be added another problem – the meningeal worm, a parasite that has caused some Llama deaths and will likely become a more serious problem in the future.

The meningeal worm, Parelaphostrongylus tenuis is so named because adults of this species live within the venous sinuses (vessels draining blood from the brain) or the meninges of the brain. (The meninges are the membranes that lie between the brain and spinal cord and the surrounding bone). The normal host for this worm is the white- tailed deer in which the parasite develops to maturity and reproduces, yet rarely causes substantial damage to the central nervous system.

In contrast to meningeal worm infections in the deer, Parelaphostrongylus infections in the Llama can be devastating. In the Llama and alpaca the infection frequently causes substantial destruction of the spinal cord. As a result, animals develop clinical changes and usually die within a few weeks following infection by the parasite. Unfortunately, once clinical signs appear, therapy is usually ineffective and most infected animals will die or have to be euthanized.

Knowing the biology of this parasite will help the Llama owner to understand how this worm causes disease, and that steps can be taken to avoid infections in his (her) animals. Thus, this article will describe the parasite's normal life cycle, some of the clinical changes caused by the worm in the deer and Llama, the prevalence of the disease, and what can (or cannot) be done to prevent infections.

Life Cycle of Meningeal Worm Infections in the Deer

The meningeal worm belongs to a large group of organisms that are collectively known as nematodes. Some of these worms are free living in the soil (requiring no mammalian host), while others are parasitic and live within the intestinal tractor other tissues of different animals. Nematodes, frequently referred to as "round worms", are one of the important groups of parasites that are treated for when animals are dewormed.

One characteristic of nematodes is that the eggs hatch, develop into intermediate larval stages and then mature into adult worms. Nematodes have either direct or indirect life cycles. In those parasites with a direct life cycle, the eggs hatch, develop into larvae, and are infective when eaten by the host animal. An indirect life cycle requires an intermediate host before the larvae become infective to the host animal. The life cycle of Parelaphostrongylus (the meningeal worm) is indirect and requires a land snail or slug as an intermediate host. (See Figure 1).

In the white-tailed deer, adult worms live within the blood vessels of the brain. They mate within the head and the females deposit eggs in the veins draining blood from the brain. The eggs are carried first to the heart and then to the lungs where they are filtered from the blood. Within the lungs, the eggs hatch and develop to the first stage larvae (L1), and move into the air spaces of the lungs. The L1 are then coughed up, swallowed, pass through the digestive tract and out into the environment in the feces. The L1 must then invade the foot of a terrestrial gastropod (snail, slug) to develop to the second-stage larvae (L2) and eventually to the infective third-stage larvae (L3). Development from the L1 to the L3 larval stages takes 3 to 4 weeks under summer conditions. Transmission occurs when deer are feeding and eat snails and slugs infected with L3 larvae.

In the deer's intestinal tract, the snails and slugs are digested and the larvae are released. The larvae penetrate the wall of the abomasum (equivalent to the stomach in the human) and enter the peritoneal (abdominal) cavity. The L3 larvae migrate randomly through the peritoneal cavity until they encounter nerves coming from the spinal cord. They migrate along the nerves until they reach the spine. Approximately 10 days are required from ingestion of the infected snails or slugs until the larvae reach the spine. The L3 larvae invade the spinal cord where they develop for approximately one month. Although the L3 larvae is actually within the grey matter of the spinal cord (a specific portion of the spinal cord), the larvae in the deer do not migrate through the spinal cord as they develop into the fourth-stage larvae (L4). Is a result, although the parasite is actually within the spinal cord and causes some local tissue destruction, few animals show clinical signs since the damage is relatively localized.

After development into fourth stage larvae, the parasites move out of the spinal cord and into the space (subarachnoid) surrounding the cord. The L4 larvae then migrate up the spine to the brain where they mature into adults, which are 48-64 mm (2-3") in length. Migration from the cord into the brain typically takes about 40 days. Within the skull, some adult worms remain in the subdural space while others invade the venous sinuses (drainage). The worms mate and the life cycle begins again. The prepatent period (the time from ingestion of the L3 larvae to the detection of the new L1 larvae in the host's feces) is reported to be 82-91 days but may be longer depending on the individual deer.

Slugs and Snails

The distribution of the meningeal worm in North America is determined by the presence or the intermediate host and the white- tailed deer. Many gastropods, including both land and snails and slugs, have been found to be naturally infected with P. tenuis and are the most important intermediate hosts for the meningeal worm in much of its northern range. Although some species of aquatic snails have been experimentally infected, these snails have not been found to be naturally infected and there is no evidence that they play a role in parasite transmission. The danger of Llamas eating infected snails does, however, vary throughout the year. In snails which are inactive (estivating) due to cold weather, the larvae stop developing and are not infective. Once the weather warms, however, the snails become active and the larvae continue development to the infective L3 stage. As a result, the danger of Llamas eating infected snails is relatively low during the winter months. In regions with mild winters, snails do remain a potential threat throughout the year.

Unlike the snail, the slug in many regions is more of an annual species resulting in the greatest potential for infections during June and July. During these months, the slugs multiply rapidly increasing the possibility of slug infestations with the L1 larvae. The slugs are also more sensitive than the snails to the effects of drying. As a result, slugs are less of a potential problem than snails in regions with dry hot summers.

Both laboratory and field studies have shown that L3 larvae can survive the winter in snails and slugs creating a reservoir of infected gastropods. The L1 larvae is also relatively resistant to cold weather and can probably survive some winter freezing. In contrast, the L1 larvae is relatively susceptible to drying and will usually die within a few days to weeks under hot dry summer conditions. As a result, although Llamas can become injected throughout the year, the greatest potential for meringeal worm infections is during early summer in most regions.

White-Tailed Deer

The second important factor in the spread of the parasite is the white-tailed deer. During the past few decades, the natural range of the white-tailed deer has increased dramatically. As a result, white- tailed deer are now found in most states within the continental United States and the Canadian provinces.

For the parasite to be a significant threat to the Llama industry, however, the natural definitive host (white-tailed deer), the intermediate host (snails or slugs) and the parasite all have to be present. Fortunately, while the range of the white-tailed deer has increased substantially, the meningeal worm has not moved as rapidly as its host. At present, it is primarily found in Eastern Canada and from the Manitoba border south through western Minnesota and east of the Mississippi River, although the parasite is rarely found in the coastal plains of the Southeast. In the Northeast, the parasite is endemic (always present) and represents a significant problem for the Llama industry. There are reports that the parasite is now being found in other parts of the continent as well. With the wide range now covered by deer and the widespread presence of the intermediate host, it is probably only a matter of time before the parasite is found in other regions of the country.

Meningeal Worm Infections in the Llama

When species other than the white tailed deer become infected, the out, is usually devastating. The meningeal worm has been a major factor in reducing or eliminating some natural and introduced populations of Cervidae (members of the deer family) in eastern North America. Moose, caribou, reindeer, elk and red deer, mule, black-tailed deer, and fallow deer are all highly susceptible to infection. Following infection, neurologic changes readily develop in these species, usually resulting in paralysis and death. Among domestic livestock goats and sheep are particularly susceptible to infection. In cattle, worms reach the central nervous system (CNS) but apparently die shortly thereafter. Given the wide range of incidental hosts (non-normal species), it is not surprising that Llamas are also quite sensitive to infection. Signs of infection in these animals can include head tilting, paralysis or the rear legs or weakness, incoordination and gradual weight loss. Progressive deterioration to the point where the animal is unable to get up often precedes death.

It is speculated that the severity of the neurologic signs in incidental hosts (e.g. the Llama and alpaca) is related to several factors. First, the worms are unusually active in the spinal tissue of the incidental hosts. When developing from the L3 to the L4 stage the parasites have a tendency to coil upon themselves within the spinal cord, rather than remaining straight and relatively quiet as they do in the white-tailed deer. As a result, damage to surrounding tissues can be dramatic. In addition, some worms in the incidental hosts do not migrate out of the spinal cord after becoming L4 larvae. These L4 larvae continue to develop and sometimes migrate within the spinal cord causing further damage. Finally, those worms that do leave the spinal cord and mature, may actually invade the brain rather than resting on the surface or within the venous sinuses as they do in the white-tailed deer. While the meningeal worm can be fatal in the Llama, it apparently cannot complete its life cycle so infected Llamas cannot infect other Llamas.

Although the meningeal worm is endemic to eastern North America, clinical cases have been reported in Llamas as far away as north central New Mexico, a non-endemic region. The affected Llamas had been transported from Virginia to New Mexico approximately two weeks prior to the onset of clinical signs. The investigators concluded that the animals had been infected prior to leaving Virginia although the animals appeared healthy prior to shipment. This illustrates, as with all parasites, that even in areas where P. tenuis does not naturally exist, Llama owners and veterinarians need to be aware of the potential of infection in their animals due to transportation from infected areas.

Diagnosis

The diagnosis of meningeal worm infections in the Llama is difficult. It does not appear that P. tenuis will complete its life circle in the Llama and produce first-stage larvae. As a result, it is not possible to diagnose meningeal worm infections based on finding L1 larvae in the feces. To further complicate matters, even if the worms did mature, the L1 larvae of P. tenuis resemble those of several far less pathogenic but related nematodes. In addition, the associated neurologic signs are rather nonspecific and may be caused by a wide variety of problems within the nervous system, including, trauma, tumors and other infectious diseases. In endemic areas, some veterinarians will use changes in the composition of cells found within the cerebrospinal fluid to help in diagnosing meningeal worm infections. Even on postmortem examination, however, the diagnosis may still be difficult since the worms are not always easily found. Laborious microscopic examination of all regions of the spinal cord and brain is often required to locate the worms.

Treatment

Meningeal worm infection is one of those diseases that by the time an owner knows she (he) has it in the herd, there is little to be done about the problem. The use of the common deworming agents, sometimes at very high dosages, have produced mixed results. None of these drugs appears to be particularly effective nor have they been approved for use in the Llama or alpaca. In one reported clinical case, ivermectin (IvomecR) was administered about two weeks prior to the onset of clinical disease presumably as part of a routine deworming program. This was followed by fenbendazole (PanacurR) after the onset of symptoms. The treatment was not effective, however, with clinical signs persisting for an additional three weeks until the two affected Llamas were euthanized. In another case, animals were transported from Virginia to the Southwest, where one Llama developed clinical disease and was euthanized. At the time of death, two additional animals began to show similar clinical signs. The entire herd was treated every 30 days with injectable ivermectin for six months without further deaths. The neurologic signs in the two affected Llamas gradually subsided and new cases did not develop. It is important to note, however, that the investigators did NOT conclude that ivermectin was responsible for the remission of signs since spontaneous recovery from meningeal worm infections, although rare and not previously reported in Llamas, has been reported in other species. On the positive side, there is some evidence that ivermectin administration to deer may be effective in preventing recently ingested larvae (L3) from migrating to the spinal cord and establishing an infection. Ivermectin will not, however, kill those worms already present within the spinal cord or head. This is thought to be because ivermectin, except in very high doses, does not cross into the spiral cord and brain. If it were possible to get ivermectin dosages high enough to kill the parasites, the results can be as severe as no treatment since ivermectin works by interfering with certain types of nerve transmissions and can be toxic.

Prevention

The most effective way to prevent meningeal worm infections is to minimize the possibility of Llama – deer contact. In many regions, fencing is the most effective method of deer control. This approach is particularly effective if a "hot wire" is included in the fencing. This can be accomplished with either one or two electrified wires incorporated into a wire fence (see Llamas, Vol. 2, No. 4, Page 25) or with the addition of a single wire to the outside of the perimeter fence. It is also important to build the fence tall enough to stop the deer from jumping it. Although not common, deer can clear six foot fences making eight foot fences a good choice in regions with large deer populations. Keeping the white-tailed deer out of the pastures be ing used by Llamas is the best means of avoiding meningeal worm infections.

Unfortunately, there is no practical method to control infection in wild populations of white-tailed deer despite the usefulness of ivermectin in preventing infections in these animals. White-tailed deer populations can range widely and there is usually no practical method to catch and treat all the deer in an are likewise, the control of gastropod intermediate hosts is also usually not feasible as they are widely dispersed in the environment (and play an important role in the overall ecological balance). The number of snails and slugs can, however, be reduced by clearing wood piles, brush, etc. from pastures used by the Llamas. Clearing or thinning heavily wooded fields may also decrease the gastropod population.

Another approach that has been advocated by some owners is the monthly treatment of all animals in the herd with injectable ivermectin. The basis for this is two fold. First, work in the white- tailed deer has shown ivermectin to be effective against the ingested larvae (L3). Secondly, ivermectin can have residual effects for up to three weeks following administration in cattle. This would suggest that ingested larvae would still be killed for up to three weeks following ivermectin treatment. Before producers start the regular high- frequency treatment of all animals, however, there are several important observations to consider. The long-term residual effects of ivermectin which have been documented in cattle have not been documented in Llamas. Assuming that ivermectin does have a residual effect in Llamas may foster a false sense of security with regard to meningeal worm infections. Another potential problem is that appropriate dosages of ivermectin (as well as all other dewomers) have not been established for the Llama and alpaca. The dosages currently being used have been extrapolated from cattle and sheep. It is not known if these dosages are optimum for Llamas and alpacas. Finally, the repeated usage of a single deworming agent encourages the selection of ivermectin resistant intestinal parasites. It is for precisely this reason that the use of rotational deworming programs (e.g. IvomecR, followed by PanacurR, followed by StrongR-T) has been advocated.

Summary

Meningeal worm infections are caused by the parasite Parelaphostrongylus, a round worm frequently found in its usual host – the white-tailed deer. When the worm infects an incidental host (e.g. Llama or alpaca), the worm cannot complete its life cycle, causes extensive damage to the spinal cord and brain, and usually results in the death of the animal. The most effective means of avoiding meningeal worm infections in the Llama and alpaca is to prevent camelid – deer contact, usually with a tall fence. Although frequent deworming of animals may kill the infective larvae stages of the parasite, preventing contact is a much safer and more effective method of control.

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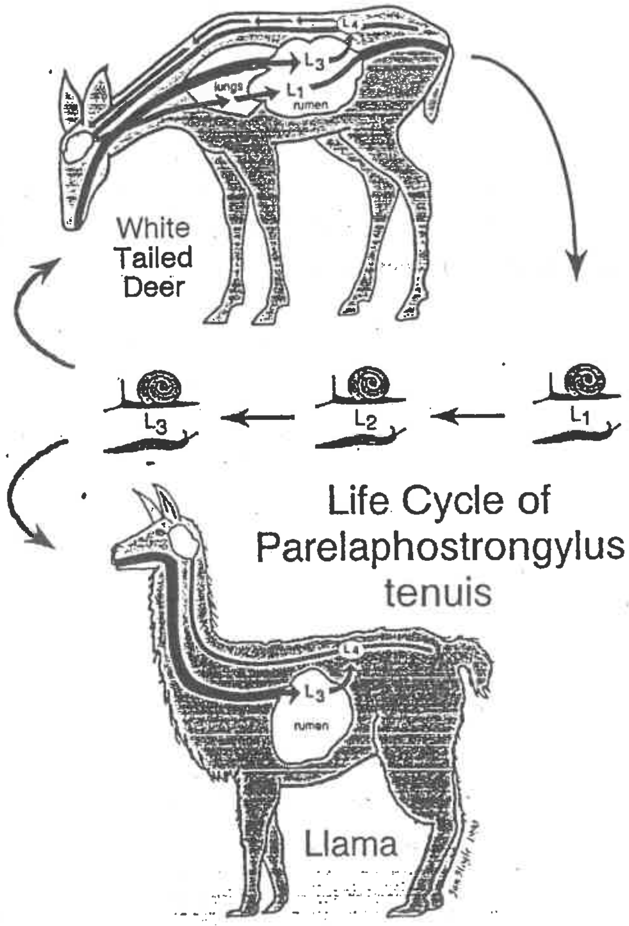

Figure 1. Life cycle of the meningeal worm Parelaphostrongylus tenuis, in its normal host, the white-tailed deer, and an incidental host, the Llama. The L1 – L3 designate the various larvae stage of the parasite as it passes from the deer through its intermediate hosts (snails or slugs). In the deer, the eggs are shed by the adult in the tissue layer (meninges) and fluid surrounding the brain or in the veins draining blood from the meninges. The eggs develop to the first larvae stage (L1) within the lungs, hatch, and break through into the airways, are coughed up, swallowed by the deer and pass out in the manure. The L1 stage invades slugs or snails and develops to an L2 and then L3 stage. When the snail is eaten by the deer, the larvae are released, burrow out of the intestines and migrate to the spinal cord where they develop to an L4 larvae. After about a month in the spinal cord the L4 migrates to the head where they develop in the meninges or associated veins into adults. The entire life cycle takes approximately 3 months. The life cycle is no completed in the Llama. The L3 larvae enter the spine and develop to L4 stage larvae but are unable to usually migrate to the head and mature into an adult parasite.

Liver Flukes in the Llama

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In the United States, liver fluke infections of ruminants are caused primarily by two species of trematodes: Fasciola hepatica (the common liver fluke) and Fascioloides magna (the deer liver fluke or giant liver fluke). Both cause extensive liver damage in infected hosts which can lead to a variety of problems including decreases in growth rate, reproductive performance and milk production, as well as death in some cases. Both parasites have long been recognized as a major cause of economic losses in the cattle and sheep industries. With the steady expansion of the Llama industry, it is not surprising that liver flukes are becoming a significant problem in this species. Unfortunately, little is known at present about the actual biology of this parasite in the Llama or alpaca. This article will discuss the life cycle of liver flukes and some of the medical problems associated with infections along with treatment and control of the parasites. Until more actual research can be conducted on liver fluke disease in Llamas, however, information concerning the life cycle, medical problems, control and treatment of liver flukes in Llamas must be extrapolated from other species.

Life Cycle

The life cycle of F. hepatica is complex requiring two hosts, a snail intermediate host and a mammalian definitive host (Figure 1). Common mammalian hosts in North America include any ruminant such as sheep, cattle and now, Llamas. Although the particulars of the cycle have not been examined in detail for Llamas, it is most likely similar to that seen in sheep and cattle. Adult flukes live in the bile ducts of the liver and eggs produced are excreted from the host with the feces (Figure 2). Under optimum conditions, a miracidium develops within the egg in about 8 to 12 days (Figure 3). The miracidium hatches from the egg and actively swims through the water to locate a particular species of water snail which serves as the intermediate host (Figure 4). Active penetration of the snail occurs and the miracidium undergoes several developmental changes/stages (sporocysts, rediae) finally emerging as cercariae (Figure 5). The cercariae are motile forms which are shed from the snail and subsequently attach to vegetation. Once attached, each cercaria secretes a cyst wall and forms metacercaria (Figure 6). The infection of one snail with a single miracidium can result in the production of over 600 metacercariae. It is this encysted form which is the infective stage for the definitive (final) host. Under favorable conditions, a minimum of 6 to 7 weeks is required for development from miradicium to metacercariae to be completed. Unfavorable conditions result in longer developmental time. After ingestion by the definitive host (the Llama, sheep or cow), the cyst walls of the metacercariae will be digested away freeing the immature flukes which then penetrate the small intestinal wall and migrate through the body cavity to the liver. The immature flukes actively penetrate the liver capsule and migrate randomly through the liver tissue for 6 to 8 weeks as they grow. After this migration period, the parasites enter the bile ducts where they mature (Figure 7). Egg production begins about 2 to 4 weeks after entering the bile ducts. Although most textbooks will list the prepatent period (that period of time between ingestion ot the infective stage and finding eggs in the feces) as 8 weeks. this period can actually be between 10 and 16 weeks for sheep and cattle. The minimum time required to complete one entire life cycle (from egg to egg) is approximately 17 to 18 weeks under optimal conditions. Neither the prepatent period nor the time required to complete one life cycle in Llamas has been documented.

The life cycle of the giant liver fluke (F. magna) is very similar to that of the common liver fluke including the need for a snail intermediate host. Natural mammalian hosts include various species of deer and elk, but infections also occur in cattle . sheep and goats. Although the scientific literature has not documented the presence of this parasite in Llamas, there is no underlying biological reason why it could not infect these animals as well. In deer and elk, eggs produced by adults leave the host and undergo the same developmental stages as for F. hepatica. Metacercariae ingested by deer and elk excyst, penetrate the gut, migrate to the liver, mature and complete one life cycle in about 30 weeks. Metacercariae ingested by live stock also reach the liver but the similarity to this part of the life cycle in deer and elk stops here. In cattle, even though the parasites may mature they become enapsulated in the liver. Consequently, eggs produced are trapped and cannot leave the liver. as a result, eggs will not be evident in the feces of infected animals. In sheep and goats, the flukes wander randomly not only through the body of the liver but also through other organs as well as (kidneys, lung, pancreas, spinal cord and brain). The migration of these parasites causes severe damage. Death of the host usually results before the parasites mature to produce eggs. The effect of F. magna on Llamas is unknown and, given the diverse reactions of cattle and sheep to infections with this parasite, their effect on Llamas is extremely difficult to predciate.

Medical Problems of Fluke Infections

The problems encountered with liver fluke infections vary according to the species of parasite involved, the phase of development and the health, immune and nutritional status of the host involved. The specific problems caused by infections with F. hepatica in the Llama have not been well documented. In sheep and cattle, however, the disease usually exists in two phases: the first phase occurs during migration of the young fluke through the liver tissue and is associated with liver damage and bleeding; the second phase is associated with the presence of flukes in the bile ducts. Damage begins as the flukes penetrate the liver. Disruption of the liver continues as the flukes migrate and feed. Early lesions evident on the liver surface may be minimal due to the small size of the fluke and the lack of an immune response by the hosts. However, as the flukes grow and migrate deeper in the liver, damage increases and the liver becomes inflamed. Necrotic damage (cellular death) occurs not only in regions where the flukes migrate but also in uninfected sections of the liver. Portions of the liver may heal with time but the repair process usually results in scar tissue formation leaving portions of the liver nonfunctional. Once the flukes enter the bile ducts had begin to mature, further damage and scarring results from irritation to: 1) the spines located on the external surface of the parasite, 2) their feeding activities and 3) their secretions and metabolic products. In sheep, migrating flukes can also cause activation of certain bacterial spores (Clostridium spp.) in the liver which, in turn, produces a disease known as black disease known infectious necrotic hepatitis). Whether the migration of flukes in the liver of the Llama could lead to a similar disease is currently unknown. Information on the pathology of F. magna in cattle and sheep is somewhat limited and is absolutely lacking for the Llama.

Most clinical signs of fluke infections are those associated with other disease. The severity often depends on whether the disease is acute or chronic. Clinical signs may include weight loss, emaciation (wasting). dehydration, icterus (jaundice), fluid accumulation within the tissues and rough hair coat or dry and brittle wool resulting in wool loss. Death may, unfortunately, be the first indication of a problem. Anemia (decreased number of red blood cells) due to both destruction and reduced formation of red blood cells is common. Suppression of the host's immune system by the flukes may be quite significant and may lead to the inability of the Llama to develop a functional immune response following vaccinations for bacterial or viral diseases. In cattle research, studies have shown that infections with liver flukes can significantly decrease reproductive performance. Further studies have indicated that treating cows for parasites (either including or restricted to flukes) can increase birth weight and weaning weight of calves. Similar effects will likely be seen in Llamas.

Diagnosis

Classically, the demonstration of eggs in fecal material and/or the recovery of flukes at necropsy (autopsy) have been the primary tools used to diagnose fascioliasis. Several methods for demonstrations eggs of F. hepatica by fecal analysis are currently in use. One such method is a screening technique in which fecal samples are thoroughly mixed with tap water and strained through a series of two or three stacked sieves. The top one or two sieves have a large mesh size (425 and/or 150 um) which allows passage of the eggs through the screens but retains the larger particulate matter. The final screen has a finer mesh (45 um or smaller) which collects the eggs. The material retained on the last screen is examined with a dissecting or compound microscope for the presence of eggs.

Another method uses gravity (or centrifugal) sedimentation to concentrate eggs of F. hepatica from a fecal sample. Flotation fluids commonly used to perform fecal flotations for most round worm eggs or coccidia will not float eggs of liver flukes because these solutions cause the operculum (cap) on the egg to rupture which results in the egg sinking. Fecal samples are mixed with tap water and strained through multiple layers of cheese cloth or a tea strainer into a container. After standing for about 20 minutes, the sediment is examined under a dissecting or compound microscope for the presence of eggs. Preparation and examination of the sediment recovered from centrifugal sedimentation is performed in the same manner as for gravity sedimentation. The only difference is that the receptacle as spun in a centrifugal which allows for faster sedimentation. Identifying features of the eggs include the large size (130-150 X 70 -90 um), the yellow color (when viewed with normal microscopy) and the shape of the eggs (oval with indistinct operculum at one end) (Figure 2). Visualization of the eggs can be enhanced by the addition of small amounts of a stain (such as new methylene blue) which provides a contrast blue color to the debris.

Advantages of fecal examinations include the relative simplicity with which they can be performed, lack of specialized equipment other than a microscope and the low cost of materials. One disadvantage is that demonstration of fluke eggs in feces may indicate a past infection rather than a current one. This is due to the fact that following anthelmintic treatment, animals will continue to excrete eggs in the feces for some time as it takes time for eggs already in the bile ducts to be cleared out of the system. As a result, the timing of the fecal exam in relation to anthelmintic treatment is important. In addition, the eggs are not evident during the prepatent period when damage to the liver has already begun. Again, the prepatent period in the Llama is unknown.

Another approach to the diagnosis of liver fluke infections uses methods which detect antibodies against the liver flukes in the blood of the host (ELISA). This approach is currently available for use in sheep and cattle. The greatest advantages to these methods are their accurate, reliability and ability to detect antibodies to F. hepatica as early as 2 to 4 weeks post-infection, even in animals with few parasites present. One disadvantage of these methods is the persistence of circulating antibodies after effective anthelmintic treatment as removal of the parasite does not result in immediate removal of the antibodies. A second disadvantage is that even though the basis for the test is non-species specific, some reagents (chemica ls) are species specific and unavailable for the Llama. With adequate research funding these reagents can be made and the test readily adapted for use in Llamas. In sheep and cattle, the only method by which infections with F. magna can be detected is by recovery of the parasites at necropsy. This is because eggs are not excreted with the feces (see above) and the blood test for F. hepatica has not been converted for use in diagnosing F. magna. Necropsy may be the only means for diagnosing Llamas infected with this parasite as well.

Treatment and Control

Many factors must be taken into account in order to present and control liver fluke infections. A practical approach is to:

1) Determine if flukes are present on your farm or in your area. Although the common liver fluke can be found across North America, the local geographic distribution of liver flukes is difficult to predict. Even in areas in which liver flukes are known to occur, infections are not always evenly distributed throughout the area. Infections will often occur in pockets with flukes present in one area but absent in fields just over the hill or across the valley.

2) Be aware of what is upstream from your farm. Waterborne snails, cercariae or metacercariae are means by which contamination (or recontamination) of your fields can occur.

3) Check fecal samples from new animals (both Llamas and other domestic ruminants) as part of an on-farm quarantine program. This is especially important if an animal is purchased from a liver fluke endemic (infected) area. As outlined earlier, timing of the collection of fecal samples is important. Also realize that if flukes are introduced onto the farm and the proper snail intermediate hosts are present, the parasite may become a long term problem.

4) Appropriate control measures must be implemented if flukes are present. The most obvious control measure would be eradication of the snail populations. This is extremely difficult as snails are very prolific and can repopulate an area within a matter of months. Chemical control is not possible in the United States as there are no molluscicides (snail killing compounds) approved for field use. The best options are management practices (such as draining or fencing an area) which reduces snail habitat or prevents grazing on infected areas. In addition, rotational or co-grazing of Llamas with sheep or cattle in areas in which flukes are present is not recommended.

The strategic use of anthelmintics is probably the best means by which to control infections with F. hepatica. The only anthelmintic currently cleared (FDA) for use in the United States is clorsulon (CuratremR, Merck & Co.), but label approval states it is for use in cattle only. No anthelmintics are specifically cleared for use in Llamas at the present time. Consequently, clorsulon and other anthelmintics used in Llamas are administered on an extralabel basis. Extralabel useage means the owner accepts full responsibility for any adverse reactions the animal might experience with the compound. Although clorsulon appears to effective in treating F. hepatica in Llamas, it is recommended that anthelmintics be used only in consultation with your veterinarian. In cattle, clorsulon is only effective against flukes eight weeks or older. Animals treated soon after removal from infected pasture will likely have immature flukes present that will not be affected by the treatment. As a result a second treatment 6-8 weeks later would be required.

Transmission patterns of liver flukes in specific geographic regions must be considered when control programs are developed. Again these patterns have not been examined for Llamas but will likely be similar to the patterns seen in cattle and sheep in affected areas. Based on research studies in these species, fluke transmission occurs in at least three environmental settings resulting in three different transmission patterns. The first is characterized by high rainfall and moderate temperatures. In this setting metacercariae may survive year round and animals will be facing constant reinfection. The second environment has hot summers and mild winters. The mild winters promote survival of metacercariae which are then killed by the hot, dry summer conditions. Maximum transmission in these regions will likely occur from late winter or spring to early summer. The third setting is just the opposite of the second and is characterized by cold winters which kill the metacercariae and cooler summers which promote survival of metacercariac. Maximum transmission will occur during late summer through the fall Treating animals at the end of the grazing season is recommended for removal of flukes from the definitive hosts. A second treatment approximately 8 weeks later is then recommended to remove any flukes which were too young to be affected by the first treatment. If one lives in an area in which pasture contamination is reduced by hot summers or cold winters, this second treatment will also help reduce recontamination of these relatively safe pastures. In areas where constant re-exposure occurs, animals may have to be treated four or more times each year.

Control of F. magna is difficult because the natural definitive hosts (deer and elk) cannot be easily treated. In regions where F. magna is endemic, control measures should include reducing access to infected snail populations (see above) and routine anthelmintic treatment. There are no drugs currently approved for use in the treatment of F. magna; however, clorsulon has been used on an extralabel basis for this parasite. As the dosage will likely have to be increased in order to be effective against this parasite, it is urged that it only be used in consultation with your veterinarian.

Summary

Liver flukes are apparently becoming a significant and increasing problem that should be considered by Llama owners. The best approach is to avoid the problem if at all possible. On-farm quarantine of new animals is one approach aimed at preventing the introduction of liver flukes into the area. This quarantine should be extended to other ruminants brought onto the farm as well. If your fields are already contaminated, routine fecal examinations to identify infected individuals or groups along with strategic use of pastures and anthelmintics are recommended control procedures.

"FEEDING ALPACAS FOR HEALTH"

by: Dr. Anthony J. Stachowski

A. NUTRITIONAL PHYSIOLOGY

1.) PREHENSION

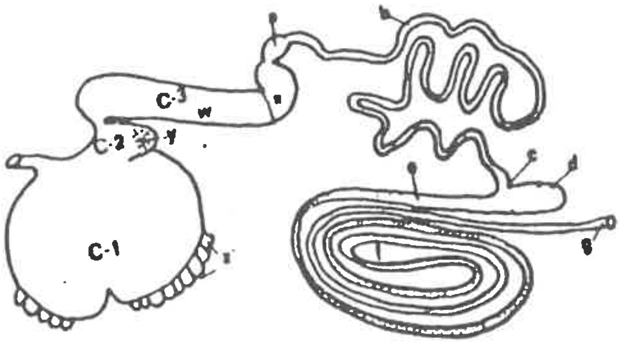
– incisor teeth and split lip

2.) MASTICATION – rumination cycle

3.) STOMACH – three compartments

4.) DIGESTIVE TRACT

GASTROINTESTINAL TRACT



13.10 Diagram of the gastrointestinal tract of a camelid: (C-l to C-3) compartments of the stomach, (a) ampula of the duodenum, (b) small intestine, (c) ileocecal orifice, (d) cecum, (e) proximal loop of the spiral colon, (f) spiral colon, (g) rectum, (w) general glandular area of C-3, (x) true stomach, (y) glandular divisions in C-2, (z) glandular saccules in C-l

B. DEVELOPING A BALANCED DIET

1.) Research at universities – guidelines

2.) Forage from pasture and hay

3.) Trace Mineral Salt and Water

4.) Forage Analysis

5.) Blood Serum Analysis

WHAT IS TOTAL RATION BALANCING?

"It is the process in which the nutrients furnished by the forage are determined and then those nutrients lacking in the forage are all applied by adding the appropriate kinds and amounts of grains and supplements."

WHAT IS A TOTAL BALANCED RATION?

"The end result of the above procedure."

FORAGE ANALYSIS

GRASS HAY ANALYSIS		LEGUME HAY ANALYSIS
88 - 90%	Dry Matter	88 - 90%
6 - 12%	Protein	14 - 20%
40 - 50%	T. D. N.	50 - 60%
45 - 35%	A. D. F.	40 - 30%
.25 - .80%	Calcium	1.0 - 1.5%
.20 - .30%	Phosphorus	.25 - .35%
.80 - 1.50%	Potassium	1.5 - 3.0%
.20 - .25%	Magnesium	.20 - .30%
.20 - .30%	Sulfur	.25 - .35%
40 - 70 ppm	Manganese	40 - 60 ppm
80 - 200 ppm	Iron	100 - 200 ppm
1 - 2 ppm	Molybdenum	2 - 4 ppm
4 - 10 ppm	Copper	6 - 10 ppm
24 - 28 ppm	Zinc	25 - 30 ppm

C. IDEAL SUPPLEMENT

1.) Daily intake of 1/2 to 1 pound
2.) High fiber 18% – 20%
3.) Protein 10% – 14%
4.) Low Energy 55% – TD
5.) Balance Minerals
6.) 100% of Vitamin A,D & E
7.) Up to 1% salt
8.) Buffer with 1% bicarbonate
9.) Add B vitamins & Biotin
10.) Low cost per pound

D. Health problem related to Nutrition

1.) Ulcer
2.) Weak or premature
3.) Angular limb deformaties
4.) Dermatitis
5.) Reproductive problems
6.) Heat stress
7.) Overweight

GENETICS — MANAGEMENT

NUTRITION

GENETICS:
CONFORMATION
BONE TYPE
PERFORMANCE AGE
GROWTH RATES
MATURE BODY WEIGHT
MILK PRODUCTION

MANAGEMENT:
FEEDING PRACTICES
EXERCISE
DESIRABLE BODY WEIGHT
MATINGS
SOIL FERTILIZATION
FORAGE MANAGEMENT
HEALTH MAINT. PROGRAM
ENDEMIC DISEASES
MONITORING PROGRAM

BALANCE RATION:
MICRO ENVIRONMENTS
ENVIRONMENTAL CONDITIONS
FORAGES FED
FORMS OF NUTRIENTS
FORAGE UPDATE
MODERN FEEDSTUFF PRODUCTION
LEVELS OF TRACE NUTRIENTS
HORMONE IMBALANCE
GENETIC POOL
NUTRIENT ABSORPTION ABILITY

MONITORING PROGRAM:
PHYSIOLOGICAL STATUS
SEX
BODY CONDITION
BODY WEIGHT/AGE
GROWTH RATE
INDIV. RELATIONSHIP
PHYSES EVALUATION
INDIV. CONSUMPTION
FREE CHOICE CONSUMPTION
CASES OF DOD
TREATMENT OF DOD CASES

GENETICS MANAGEMENT

NUTRITION

NUTRITIONAL RECOMMENDATIONS FOR ALPACAS – TOTAL DIET

CRUDE FIBRE – 25%
T.D.N. (Energy) 55 – 65%
PRTOTEN – 10% for adults
12 – 14% less than 11/2 yr. old
CALCIUM – .8 – 1%
PHOSPHOPHUS – .6 – 1%
MAGNESIUM – .2 – .4%
PATASSIUM – .5 – 2%
SODIUM – .1%
CHLORIDE – .2%
IRON – 50ppm (minimum)
ZINC – 150ppm
MAGANESE – 40ppm
COPPER – 10 – 20ppm
MOLYDENUM – 2. 2mg
SULFUR – .25%
COBALT – .2 ppm
IODINE – .3 – .5ppm
SELENIUM – 1.5mg (3ppm)
BIOIIN – 1mg
VITAMIN A 250,000 IU/pound supplement
VITAMIN D 3,000 IU/pound supplement
VITAMIN E 250 IU/pound supplement

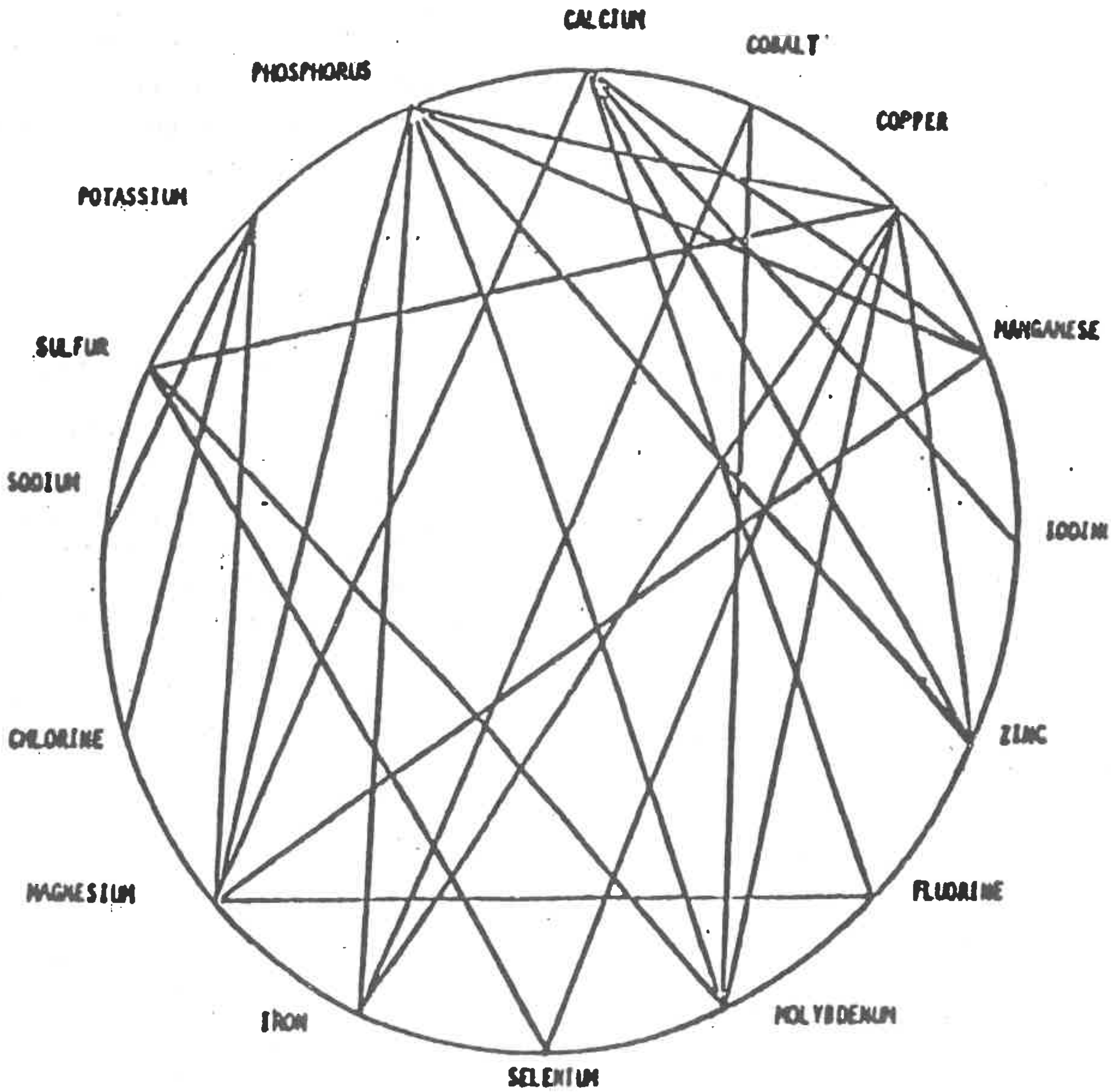
SUMMARY

In summary, the alpaca is an efficient converter of high fiber, low protein vegetation into energy and body mass.

Of primary importance to proper nutrition are pasture, hay, trace mineral salt and clean water.

Secondary supplements are only necessary to balance the total diet.

MINERAL INTERRELATIONS



ALPACA – SPECIALTY ANIMAL FIBRE

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BACKGROUND

To understand Alpaca fibre it is necessary the animal, its genetic roots and the part it plays in the world's specialty, animal fibre trade.

The Alpaca (Llama pacos) is one of 4 Llama species or South American camelids: the alpaca Llama (Llama lama), guanaco (Llama guanicoe) and the vicuna (Llama vicugna) (Pumayalla and Leyva 1988). The vicuna, a wild animal, produces the rarest of the specialty fine animal fibres in the world and is on the endangered list. The guanaco is also a wild animal and is regarded as the forefather of both the alpaca and Llama.

The people from the Inca civilisation were great agriculturalists and ample evidence of this, in the form of terraced gardens and massive aqueduct irrigation systems, is still very visible in the Andean chain. A train trip from the Andean city of Cusco in Peru, to the famed "Lost City of the Incas," Machu Picchu, winds through many of these high attitude valleys where the results of the Inca's animal breeding prowess are also visible. I refer of course to the herds of alpaca and Llama. Both these animals originated from the guanaco; the Llama was bred specifically as a pack animal and the alpaca as a fleece bearing animal.

From a fibre point of view, the Llama is not regarded as a fleece producer, however fibre is harvested from them and after dehairing, used in the alpaca trade, as it is difficult to differentiate between the fibre from these animals. Alpaca were introduced into Australia during the great Acclimatization Society movement in 1857 and 1858. In all 359 animals were imported but they failed to survive (Escobar 1984).

WORLD PRODUCT

Smith (1988) indicated that the world trade in alpaca and Llama fibre amounted to only 4m kg, in a trade in specialty animal fibres totalling 142,000 tonnes (mohair accounts for 16%). We indicated that the quantity of fibre being produced was increasing.

Production of 4m kg should be put into context with modern wool processing. This amounts to the equivalent of 13,600 farm bales of wool which would be processed into top in one modern wool combing plant in about 2-3 months. It would produce sufficient yarn to make only 12m knitted garments such as pullovers, less than l/year/head of population in Australia.

What does this mean to prospective producers?

It is important to determine the market in which you wish to operate.

A small local, hand spinning market will result in spot prices up to $75/kg (above world price), but you have to question "where to next?"

FIBRE PROCESSING

To supply a small local processor of hand knitting yarns would require low farm-gate fibre prices to enable the Australian processor to compete with cheaper imported yarns. Upheavals in cashmere trading in China, in 1978, drew world attention to the production of the speciality animal fibres . This trade has traditionally seen very stable prices with the manufacturing in the hands of a small number of processors. Names like Dawson International Fibre, Forte, Amicale, Biagioli, Modesto, Muller etc. are synonymous with processing of the speciality fibres. Because of their high value, relative to wool, great care is taken in processing.

The alpaca is regarded as a single coated animal but the Llama is double coated. Adult fibre needs to be dehaired to remove the coarse outer coat or guard hair. Dehairing is a specific and closely guarded industrial secret. It is however quite common to see undehaired Llama and alpaca garments but these are primarily traditional patterns made in craft circumstances and not accepted by the world fashion trade. Modern carding equipment acts as a dehairer, removing a proportion of the coarse, shorter primary fibres in alpaca during the top making process.

Much of the machinery is old for example woollen system spinning 'mules,' 150 years old, are still in use. This has built up a tradition and almost a craft knowledge for effective processing. Slower spinning speeds are used in the production of specialty fibre yarns and hence costs of conversion are significantly higher.

Peru, however, is now undertaking first stage processing of a significant proportion of the raw product (Ross 1988) and exporting in the form of yarn and fabric. This is likely to force traditional processors in Europe and the USA to seek alternative sources of supply. Political upheaval in South America, especially Peru the major supplier, has also added to the problems of supply.

SCIENTIFIC KNOWLEDGE

Very little is known scientifically about these fibres or the production of them and it really has only been within the last 10 years or so that scientific knowledge has blossomed. Australian scientists are world leaders in this field, primarily because of their specialised work in cashmere production and their traditional base in wool technology and production.

The previous lack of interest relates primarily to the supply of these fibres originating from third world countries, often from isolated growing areas, with the fibre reaching the sea ports and market place after long and difficult journeys.

We are told that the alpaca and Llama animals have specific high altitude altitudes (Pumayalla and Leyva), but only time will tell if these altitude conditions are required for high fleece production or whether reproductive function is affected in any way.

Similar thoughts were raised in relation to Cashmere goats yet we see cashmere production in this country which equals and in some cases exceeds that from traditional growing areas.

Peru, like China with its cashmere, is the major alpaca producer with 2.5m alpaca and 0.8m Llama (Wilkinson 1990) giving an annual production of approx. 3m kg, representing 90% of world trade. Per head production is stated as 2.0-2.6kg/head however these figures do not add up. These estimates of population may be incorrect, significant numbers may not be shorn or the 3m kg of fibre may refer to the quantity of fibre exported. The latter is more likely.

Escobar reported official Peruvian Government figures for 1977 of 2.4m animals producing 2.5m kg yet in a later reference cited, production ranged from 1.2kg – 6.kg/head.

In the 5 year period, 1975-80, the alpaca population in Peru increased 60% the percentage of population shorn increased front 34% to 40%. Per head production increased 11% to 2.67 kg, providing a total increase in production of 40% to 3.4m kg.

Like most of the specialty fine animal fibre producers these animals are "two coated", producing fibre from primary and secondary follicles. Selection of the alpaca over time has seen the downy undercoat get coarser and the coarse hairy outer coat get finer until today we have a "single" coated animal, much in the manner of the merino sheep. It is common however to find up to 10% kemp fibre in alpaca. The physiology of the animal sees a tendency to produce the finer secondary fibres during late summer and autumn whilst the primary fibres are continuous growers. Testing for diameter at different times of the year is likely to show seasonal differences. Alpacas are shorn and the fibre is then classed for commercial sale to the manufacturing textile trade.

COLOUR

Fibre colour is extremely variable ranging from white to black with intermediate shades. Many animals show a considerable range of colours over the body which makes fibre sorting more difficult. The majority of fibre is used in its natural form, without dying, because of the diverse shades produced and the production of "natural look" garments. The darker shades are predominantly used in the weaving trade (Ross 1988).

The tan or cinnamon colours are favoured because of the likeness to vicuna. Escobar believed that up to 90% of the cinnamon fibre was sold (substituted) as vicuna at heavily inflated values. He quoted price ratios of up to 4:1 in 1970. This substitution may have diminished substantially as there is almost no vicuna traded in the world today.

There is however a tendency for breeders to select and try to fix a line of white animals. White fibre is favoured from a manufacturing point of view, as it provides processors with dying flexibility and allows for pastel shade dying. All the specialty animal fibres tend to be presented in pastel shades. Pastel dying also allows fibres to be dyed at lower temperatures which maintains superior "handle" or softness.

In addition there is a psychological effect on human perception of "handle" or softness whereby dark shades "handle" up to 2um coarser than pastel dyed fabrics.

From an animal production point of view the colour inheritance of the camelids is believed to be very complex.

FINENESS STANDARDS

The American Society for Testing Materials (ASTM), produces the official American Standards for textile fibres.

There is a standard test method (ASTM D2252-85) for the fineness of alpaca which forms the basis for world trade in this fibre. The standard specifies a number of types based on fineness and supplies extra non-mandatory information on the description and fineness variability of alpaca types. These are presented below in Table 1. The Standard specifies the measurement technique (D2130 or D3510), which if followed, will provide precision limits of +/-0.5um. Measurements outside this 95% confidence limit are subject to normal textile trading claims and guarantees.

Table 1. ASTM Standard Classification.

TYPE	Mean Diameter (um)	s.d. (not mandatory)
T EXTRA	UNDER 22.00	N/A
T	22.00 - 24.99	6.6
X	22.00 - 24.99	6.6
AA	25.00 - 29.99	7.7
A	30.00 - 39.99	10.2
SK	OVER 30.00	N/A
LP	OVER 30.00	variable

The trade descriptions used are as follows:

BREED/Strain Symbols:

H – Huacaya

S – Suri

AGE:

T – Tui, 1st shear, 12 months growth

A – Adult, 12 months growth

TYPE: T – Tui, 12 months age

TSK – Tui Skirtings, expected to range from 24 – 28um

X – Extra fine adult

AA – Medium Adult

A – Coarse

SK – Skirtings

LP – Locks and Pieces

COLOURS:

B – Blanco, White

LF – Light Fawn

C – Castano, Tan

P – Dark and Piebald LENGTH:

CB – 76mm and over, (Combing)

CL – under 76mm, (Clothing)

Leyva (1979) classified fleece from 3,762 head and reported the following proportion of fleece falling into various classes (Table 2).

Table 2. Fibre class proportions in a herd.

TYPE	% PRODUCED	um RANGE
X	2.8	17.25 - 19.37
AA	52.1	21.36 - 24.56
A	17.0	32.65 - 37.39
SK	4.7	42.30 - 49.00
LP	23.4	37.33 - 44.20

FLEECE PRODUCTION

There is little recorded data on production levels or range of production. Pumayalla and Leyva, describe 2 sub-species of alpaca; the Huacaya and Suri, the former comprising 85% of the population. They are different in body conformation and the arrangement of fibres over the animal.

The Huacaya produces a fleece more akin to a comeback sheep fleece with a definite fleece structure, whereas the Suri fleece is straight, lustrous and has a tendency to hang in curls, somewhat akin to a mohair fleece. These differences need to be recognised by breeders in any animal selection programme.

It is difficult to get an accurate picture of fleece production and characteristics from the published data. The most reliable however, are provided by Escobar for over 20,00 animals. This data shows fleece weights over 12 age groups to average 1.7 kg at 31.8 um mean fibre diameter (mfd). The relationship of age and the various animal and fleece characteristics are provided in Figs. 1-6.

It can be seen that there is little difference, between the types, in the effect of age on either liveweight (Fig.1) or fleece production (Fig.2). Maximum fleece production is attained at 3 years of age then declines over the next 9 years. No doubt this is the result of both reproductive effects and nutritional stress when pregnancy and lactation are added to the females production load. Pumayalla and Leyva reported fleece production of young animals as 2.6kg, similar to adult males with adult females only producing 2.0kg, somewhat different to these figures.

Fleece production however varies with type, age and sex of the animals (Table 3).

FIBRE DIAMETER

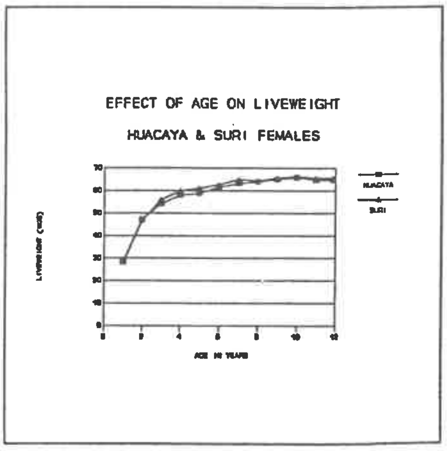
As with all animal fibres, production levels and fibre diameter in particular, are affected by levels of nutrition, animal selection, age and sex. Table 4, outlines fineness characteristics of 4,285 alpaca animals.

It is interesting to note the sex differences of the young animals and the age difference for the 4 year olds. Fibre diameter increases 3-4um over that period then stabalises.

The relationship shown in Fig 3. is not surprising with the majority of the fibre diameter increase occurring in the first 2 years of production The blip at 7 years is unexplainable but may correspond to increased mfd of barren females which are then culled. A similar explanation could also be made for the 11 and 12 year olds.

There is also a high coefficient of variation. Another fibre with similar fibre diameter is Cashgora but the CV of that fibre is only of the order of 23-25%.

The coefficient of variation is a way of expressing the amount of variation in diameter in the fleece in proportion to the mean figure. High CV can be associated with higher levels of unevenness in yarn manufacture.



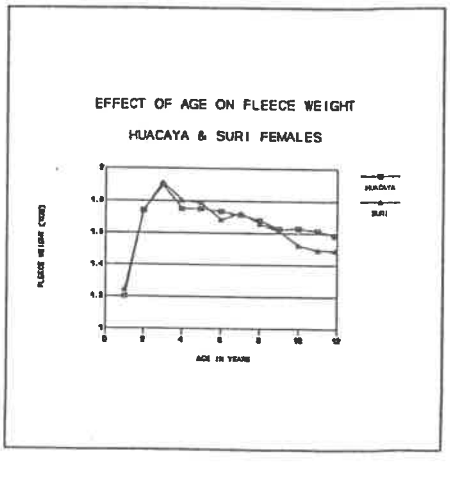


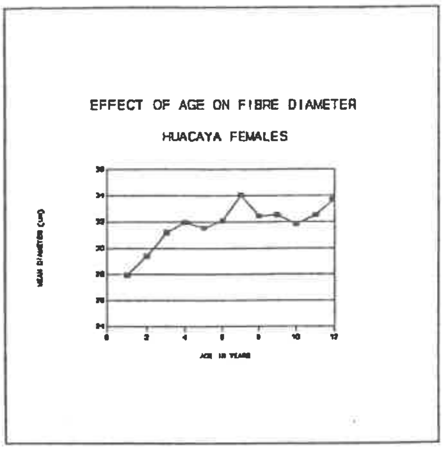
Table 3. Effect of type, age and sex on fleece production.

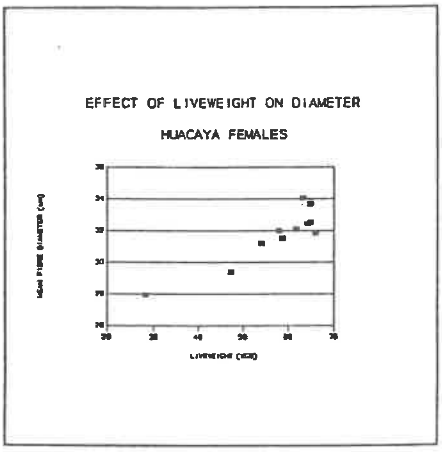
SEX	TYPE	AGE	KG/YEAR
MALE	HUACAYA	ADULT	2.6
"	SURI	"	2.3
FEMALE	HUACAYA	"	1.7
"	SURI	"	1.8

Table 4. Alpaca fibre diameter characteristics.

SEX	AGE (months)	DIAMETER (um)	s.d.	CV%
FEMALE	10	20.71	5.66	28.0
MALE	10	21.58	6.28	29.0
FEMALE	48	25.17	6.80	27.0
MALE	48	24.60	6.75	27.0
FEMALE	72	25.15	6.96	27.0

ref. Pumayalla and Leyva





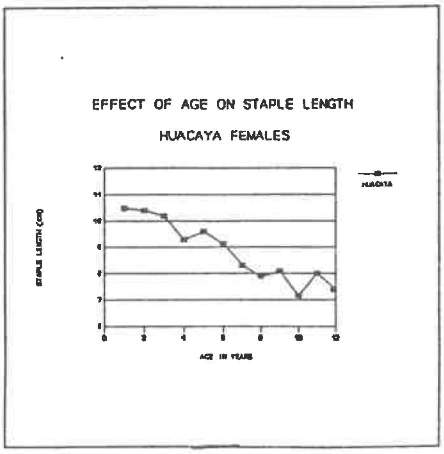
There is a relationship between liveweight and mfd (Fig 4.). As the animal ages and gets bigger the mfd increases. It is not surprising therefore that Figs. 3 & 4 show a similar relationship.

Such changes are also seen with other fleece bearing animals. No doubt similar relationships also exist for other fleece characteristics and breeders could therefore make good educated guesses on effects of likely management and breeding decisions, in the absence of more specific data.

Escardo (1984) believed that when alpaca were provided with better nutrition than is available from native Andean highlands pastures then better fleece production will result. Escobar agreed and discussed the phenomenon known in Australia as "hunger fineness" as being applicable to Andean alpaca. Escobar reported the effects of improved nutrition, with a lucerne diet, in high altitude conditions by reporting differences in production (Table 5).

The most interesting point was a significant increase in mfd for the females. This increased from 27.41um and would result in quality down grading from AA grade to A grade, Tuis from 21.61um and Baby Huacaya from 20.90um. Both the younger groups were downgraded from T Extra grade to AA Escobar used production details, provided by Marshall et.al. (1981), and applied 1983 US fibre prices to show financial differences in feeding regimes.

Phan et.al. (1988) using scanning electron microscope (SEM) techniques indicated that alpaca fibre had a mean of 26.1um (sd 8.9) in the range 22 – 30um, similar to that reported by Villarroel (1963). They reported that Llama fibre was 26.1um (sd 8.9.) in the range 22.5 – 32.5um. They quoted ASTM test method D629 which puts alpaca at 26-28um and Llama at 20-27um. They also reported a scale frequency of 10/100um for both types of fibre which is similar only to vicuna and yak fibre.



The SEM technique used by Phan et.al. to measure fibre diameter produces lower values, because the measurement is carried out under vacuum. Villarroel's data would indicate that the data presented in Table 2 was perhaps derived from the minority Suri type animals.

Alternatively, significant gains have been made in selection of animals for reduced fibre diameter. Reductions in diameter of this order (5um) would however be quite extraordinary.

Phan et.al. indicated that the closeness of the reported range of values for alpaca and Llama may well be as a result of the South American farmers not discriminating in price for the fibre sold to commercial interests and therefore overlaps are consequential.

Depending on sex and age the mfd of Llama ranges from 25.55 – 30.68 (s.d. range 9.2 – 15.2) which gives a CV range of 29.2% up to 41.6 (Vidal & Villarroel 1967).

The Llama fibre has 44% of the fibres between 25-30um and the remaining 56% between 50-70um, slightly finer than the guard hair seen in Cashmere fleeces (Couchman (1984).

When dehaired, the fibre diameter of the Llama down was 20.3um and 26.5um for baby and adult down respectively (von Bergen). The adult fibre being the equivalent to X grade and the baby Llama at the finest end of the T EXTRA grade.

FIBRE LENGTH

In common with the other specialty animal fibre producers, length of growing season and nutrition influences fibre length, in general this is of the order of 90mm-115mm in staple length, similar to combing length wool suitable for the worsted spinning system. This length however is at-

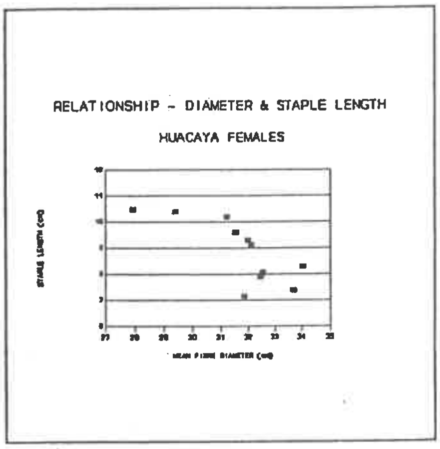
Table 5. Effect of improved nutrition on fibre production characteristics.

TYPE	15m LW GAIN	CONTROL	FLC WT.	LENGTH	um	YIELD %
DAMS	21.54	2.6	0.40	2.33	5.15	4.14
TUIS	33.46	15.37	0.54	1.78	6.22	10.39
BABY H	59.75	37.36	0.79	1.79	6.83	10.80

tained over a harvesting period of 18-24 months (Wilkinson 1990).
Fibre length and mfd are related, increases in mfd will be associated with increases in mfd. This should not be confused with the relationship shown in Fig. 6. The information in Fig.6 relates to the mean figure from a large number of animals and is confounded by the effects of nutritional, liveweight, reproductive status etc. Selection for increased fibre length is likely to result in increased fleece weights.

YIELD & GREASE CONTENT

Once again there are parallels with the other "specials" when scouring yield, grease content and other impurities are examined. Table 6 provides details on these characteristics (Pumayalla and Leyva).



With such low grease levels and modern scouring techniques, processors are forced to add oils to fibre, after scouring and carding, to assist in spinning.

FIBRE CROSS SECTION

Unlike most other animals, the camelids produce an elliptical fibre in cross section which makes a very distinguishing feature. All the camelids produce a highly medullated fibre, including the fine undercoat fibres. The medulla can be either continuous or fragmented and medulla diameter increases as fibre diameter increases. This feature has an effect on the dying capacity of the fibre.
Significant (differences occur between the 2 sub-species in respect to diameter. The elipticity of the fibre affects processing performance and fabric behaviour. These differences are shown in table 7.
It is interesting to note a consistency in the degree of elipticity despite the differences in; sub-spp fibre diameter and age (although not identified by the author) for the 2 finest samples. This is a major point when cleaning with fibre identification.
Fibre identification is an important factor when dealing with the specialty animal fibres primarily because of their scarcity, hence price, and the willingness of unscrupulous industry sectors to dilute or substitute cheaper fibres to reduce production costs.
Wool is the most usual alpaca substitute and often to a level of 10- 30% substitution whilst alpaca itself has been substituted for vicuna in the past.
It is important to distinguish between substitution and blending. Blending is an important feature of textile processing and when a blend is made up, the proportions of the blend are selected to achieve a specific processing or end use attribute. They are clearly identified in the product labelling and no attempt is made to disguise the details of the blend.

CELL STRUCTURE

Tucker et.al. (1988) undertook analysis of the internal cortical cell structure of speciality animal fibres. Transmission electron microscopic (TEM) details, which look at the internal cell structure, were used for alpaca and Llama. These show no appreciable difference with predominantly an ortho cortex structure, but vicuna and guanaco both had a bilateral structure; quite unlike wool which has an ortho/para cortex causing crimping.

CUTICLE SCALE STRUCTURE

As with all fibre identification work there is considerable overlap in fibre characteristics for fibres. Scale frequency is a common form of fibre identification and Fig. 7 (Phan et.al.) shows the bivariate log- normal distribution for alpaca and camel hair, developed by an Australian scientist (Teasdale). It can be seen that the majority of fibres could be identified by this technique however some overlap occurs.
The cuticle cell structure of both the alpaca and Llama were described by Phan et.al. (1988) as mostly cylindrical with near and ripple-crenated margins which run perpendicular to the fibre axis. They believe that by using SEM techniques and dividing fibres into 3 major groups then identification can be made and fibres can be differentiated. Their flow chart is provided in Fig. 8.

CHEMICAL COMPOSITION

Alpaca and Llama fibre however were shown by Rivett et.al. (1988) to have significant differences in the fatty acid components of their protein content (Table 8).
Table 8. Fatty acid components of alpaca and Llama fleeces
Similarity they found differences in fibre diameter, s.d. and the amount of solvent extractable material from the samples they tested. Fibre diameters were 40.7um and 19.5um, s.d. were 9.8um and 2.6 and extracts were 263 and 89 mg/10g of dry fibre for alpaca and Llama respectively. This would indicate that the extracted sterols were more accessible parts of the cell membranes of the alpaca fibre and that the extracted material for the camelids was greater that for wool. The mfd of the Llama would indicate that only the secondary "down" fibres were tested and this may have influenced the results.
Tucker et.al. also examined the high sulphur protein content of a range of specialty fibres and found the camelids to have much higher amounts of the amino acid cystine, than wool, cashmere, camel hair or mohair.

FIBRE STRENGTH

The strength of fibres is an important consideration in processing. Fibre breakage affects the length of the fibres and therefore spinning ability and yam quality. In addition, the quantity of very short fibres, called noils, produced primarily during processing by fibre breakage, reduces the amount of fibre a spinner is able to use. A high noil:top ratio means that a processor has paid full price for a higher quantity of unusable fibre and therefore that yarn becomes very expensive in relation to another.
Considerable work has been done in the wool industry to understand these relationships. Fibre length in the top is the second most important factor in the value of that top and both fibre length and strength play a significant part in determining what that will be.
The Huacaya has a tensile strength equivalent to 385-500g/cm"2 against the Suri with 325-385g/cm"2, greater tensile strength than wool at 285-385g/cm"2 (von Bergen).

SPECIFIC GRAVITY

The specific gravity of alpaca is similar to many of the other animal fibres i.e. 1.33g/cm"3.

FOLLICLE DENSITY

Arana and Calpio (1972) reported midside follicle density as 15/mm"2 and neck density as 20/mm"2 with the extremities as 10/mm"2. Other workers (Martin & (Gaitan 1969) reported a mean of 16.9/mm"2 with a S:P ratio of 7.2:1.
In comparison, merino sheep and cashmere goats have follicle densities of 60/mm"2 and 25-30/mm"2 respectively (Couchman 1984).

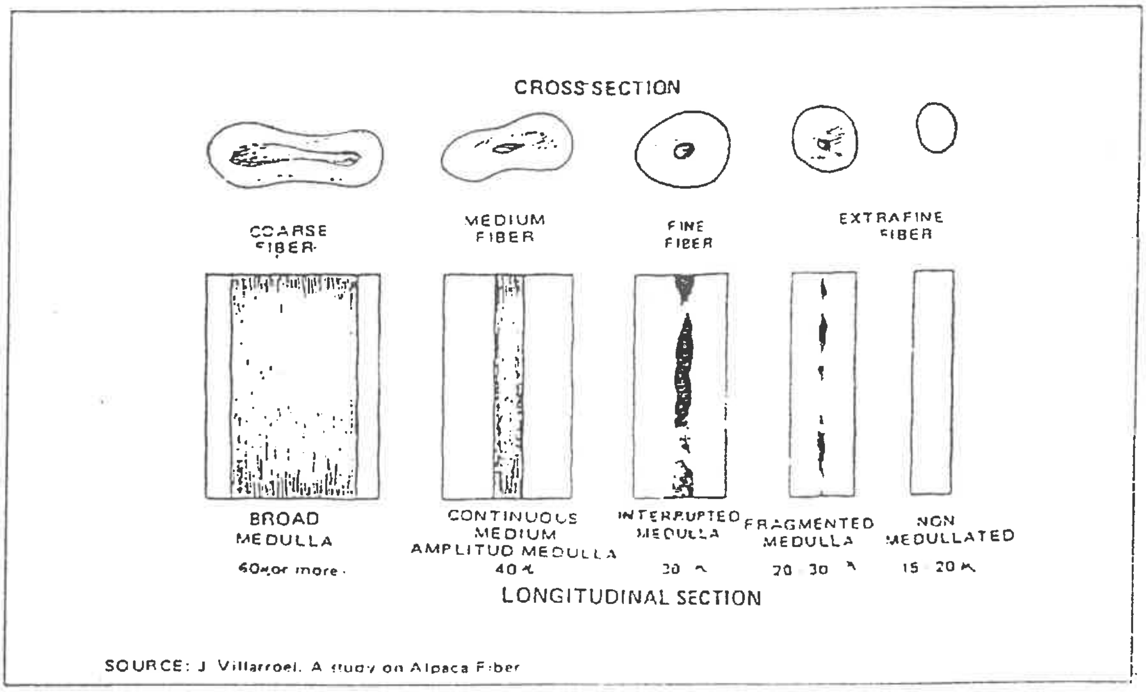
THE CHALLENGE

The challenge is for breeders to produce marketable parcels of fibre.
This will be associated with attempts to increase the level of production per head. There are a number of avenues to achieve this. Specific gravity of the fibre is likely to

Table 6. Yields and grease content of Alpaca.

CHARACTERISTIC	VALUE (Range)
YIELD (%)	84.29 - 91.96
GREASE (%)	2.20 - 3.91
Veg.Matter (%)	1.80 - 2.70
IMPURITIES (%)	3.40 - 10.81

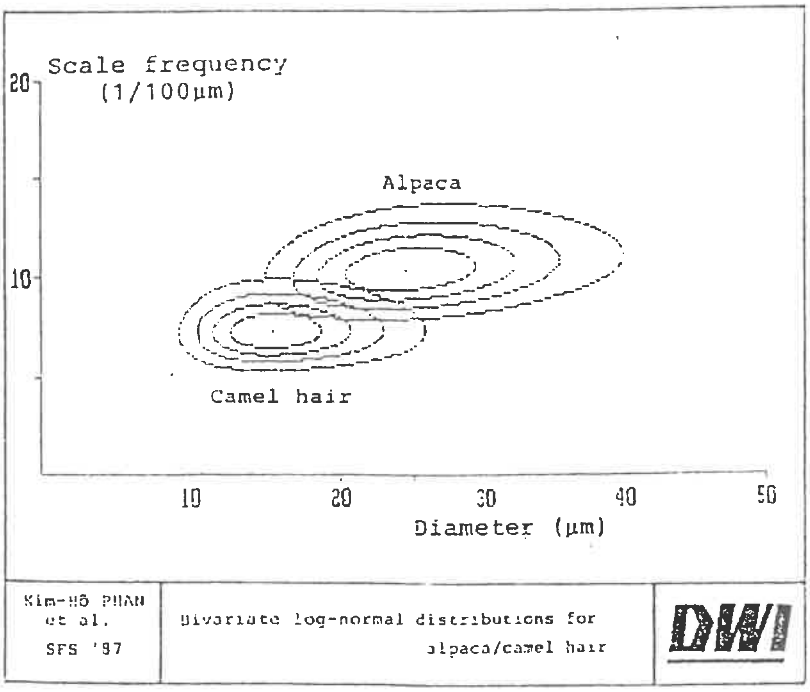
INTERPRETATION OF THE CLASSIFICATION BY WILDMAN (1954) APPLICABLE TO ALPACA FIBER: RELATIONSHIP BETWEEN ELIPTICITY, DIAMETER AND MEDULLATION



SOURCE: J Villarroel. A study on Alpaca Fiber

Table 7. Elipticity of Alpaca (ref. Villarroel (1963)

SUB-Spp	DIAMETER (um)	s.d.	MAJOR AXIS	MINOR AXIS	ELIPTICITY
HUCAYA	31.8	12.2	33.2	25.9	1.28
	31.7	8.1	36.6	30.1	1.22
	30.2	6.9	33.2	27.6	1.20
	22.4	6.3	25.1	22.2	1.18
SURI	28.8	6.9	32.8	27.0	1.21
	28.0	4.1	30.4	24.6	1.23
	25.2	5.0	29.5	25.0	1.28
	22.4	5.4	25.5	20.5	1.15



remain stable so this avenue can be disregarded. This therefore leaves the other fleece production characteristics of fibre length, diameter, follicle density and increased follicle population. The first two are however contra indicating i.e. increases in length normally results in increased fibre diameter which is undesirable.

Increased follicle population relies on increased body size associated with retention of follicle density or increases in follicle density through selection. The most likely route is fibre length.

Fibre quality is affected by breeding and selection decisions made by the farmer. Selection for fleece weight in all fleece producing animals is normally associated with increased fibre diameter. Low fibre diameter is what specialty animal fibre is all about. Be warned now, increase fibre weights at your peril. Without care and a great deal of thought, you may be putting yourselves out of the specialty fine animal fibre business.

To produce marketable parcels of fibre for the world trade, you have to be thinking in terms of tonnes of fibre, graded by colour and diameter. This marketing challenge has been faced by Cashmere and Cashgora goat producers in this country.

They have organised a marketing system, controlled by growers, with contractual arrangements with 3 of the worlds major processors. Price is negotiated on a six monthly basis on agreed classifications of fibre based on objective fibre test results undertaken by the Australian Wool Testing Authority. These tests, developed by me (Couchman 1984), would also be able to determine the quality of alpaca fibre and could form the basis of trading on the international market. In fact these tests now form the basis of international trading in cashmere and cashgora fibre. In addition, these tests will form the basis for objective selection of superior quality breeding stock.

In Peru the proportional value of the animal is regarded as 60% fibre, 30% meat and 10% fur or hides. This must be considered in Australia in setting animal prices. Animal prices should reflect the economic value of the products produced. This does include surplus stock and breeding value but that in turn must reflect the value of saleable product. Care must be exercised in any decision to "register" animals in a stud book. The angora goat industry is based on animal registrations and not on fibre production. It is estimated that $12m has been expended on registration in that industry yet registration has done nothing to improve the level of actual fibre production of those animals. Registration of animals of the grounds of "pure bred stud stock" is not justifiable or recommended. It can also result in restrictive trade practice.

To maintain a sustainable industry then a suitable animal breeding base or critical mass of animals must be available.

Maintenance of viability by the use of animal sales at high prices results in a dirty word in Victorian financial circles today – PYRAMID selling and the connotion is the same; a lot of small people ultimately get hurt.

This warning is important, I also gave it to the cashmere and cashgora down fibre industry some 10 years or so ago. They did not Register animals in a stud book yet still sell "stud" animals on the basis of their down producing ability not looks. Without a product to market you don't have an industry. Trading in animals is not what will make a stable industry.

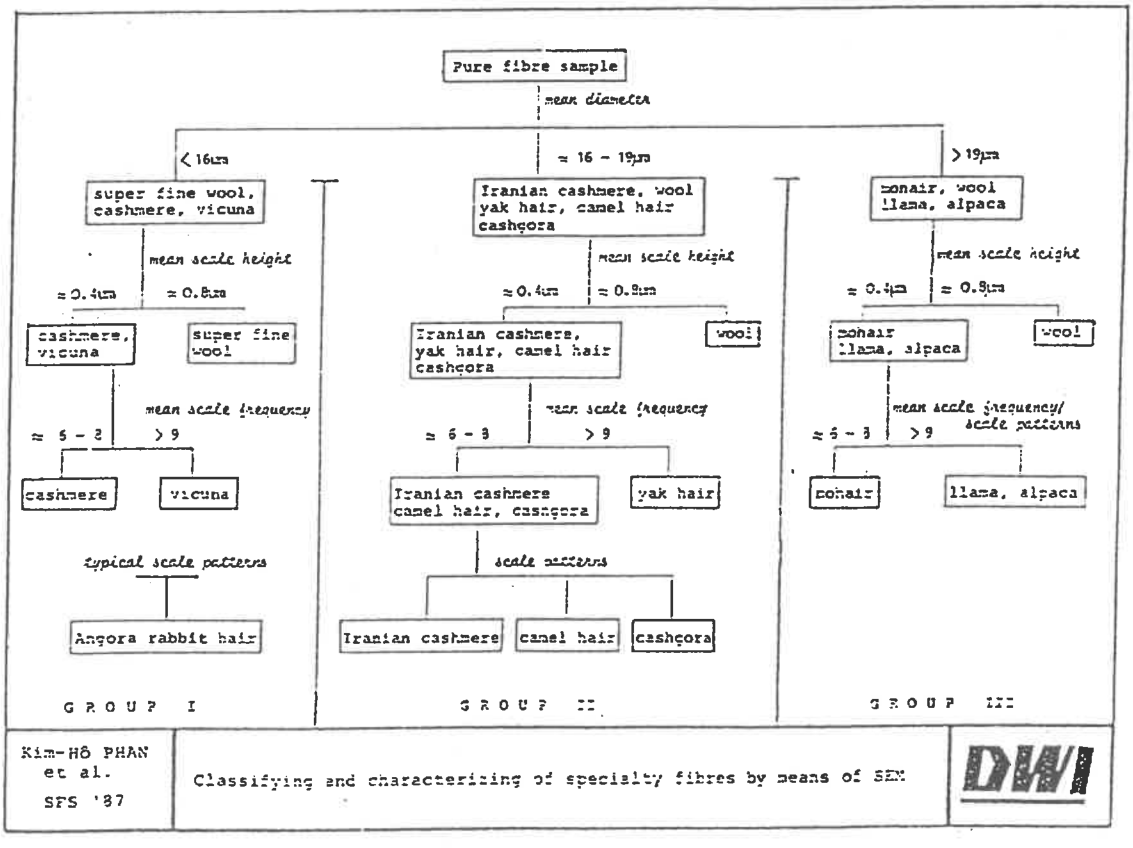


Table 8. Fatty acid components of alpaca and llama fleeces

SPECIES	C16:0	C16:1	C18:0	C18.1	C18.2
ALPACA	21	-	37	19	8
LLAMA	13	-	26	9	4