Herd Health & Management

The nature of a llama/alpaca herd health program has been markedly influenced by variables including owner's background, numbers of animals, purpose of animals, geographical location, economics and, quite understandably, the background and species orientation of the veterinarian involved. In the following, a herd health program is discussed that includes some firm recommendations based on research, medical, and management observations of the author. In addition, some theoretical options will be discussed that have been shared with the author by professional colleagues and llama owners.

The reader should not assume that this is the llama/alpaca herd health program, but rather a basic model by which to develop a custom made program for the client and herd under consideration. For the client whose goals include breeding and subsequent sales, a reproductive herd health program will emerge as the launching pad for other aspects including neonatal care, nutrition, records, immunisations, parasite control, grooming/ foot care and facilities design. For the backyard companion animal owner and back country packer, only a portion of a complete herd health program may be applicable.

In general, one should be prepared to encounter two extremes of clientele types. On the one hand is the novice livestock owner, having little previous experience with any pets or farm animals, while on the other is the extremely well informed llama owner who is likely qualified to advise you on many aspects of llama management. It will be assumed that the reader has access to other reference books to provide background information about anatomical and physiological uniqueness of the new world camelids.

Reproduction

While the new world camelids are capable of breeding successfully at any time of the year, a tendency has emerged to avoid extremely hot and frigid seasons. The 11.5 month gestation period allows breedings to be easily spaced to avoid these compromising periods. This also creates two windows a year in Northern climates during which time problem breeding can be aggressively pursued and creates options as to when to introduce young females into the breeding program. If a female of potentially breedable age (i.e. greater than 12 months and weighing two-thirds of anticipated adult weight) is successfully bred in the spring, she obviously stays with the spring birthing group of females. If, however, she does not breed successfully with two mating attempts, don't assume she has a problem but rather move her to the fall breeding group. The point being that there is a wide range of age for puberty expression. The wise breeder should be encouraged to detect and pursue early puberty in both the female and male, so as to improve reproductive performance overall. However, forced puberty due to owner expectation is to be avoided. The recently birthed female llama, having no complications, will have extremely rapid uterine involution and will be capable of successful rebreeding as early as 10 to 21 days post partum. Breeding at the earliest date to produce a pregnancy may increase the incidence of resorption, so generally it would be recommended to wait until at least 14 days post partum to breed.

Breeding programs vary widely from the extremes of pasture breeding to strictly managed hand breeding. Bearing in mind the follicular wave pattern 2,3 influencing female receptivity, hand breeding subjects female llamas to some unnecessary breedings. Without male exposure, most female llamas will have maximum male receptivity on an approximately 12-day cycle during which time the ovulatable follicle reaches maximum size (10 to 14 mm). Without breeding, the follicle becomes atretic and is replaced by another follicle. Periods of minimal male receptivity are also observed on a 12-day cycle, however many females will still be bred by an aggressive male in hand breeding programs.

A challenge for the breeder as well as the veterinarian is to detect the female llama who is the most receptive and to minimise the numbers of services necessary for a successful induced ovulation breeding. Ultrasound monitoring of follicular growth will facilitate correct exposure for hand breeding.1 A veteran male in a pasture breeding program will detect these receptive females by their proximity to him as well as their excretion of oestrogen conjugates in the urine. As such, there will tend to be one or two services per breeding. For hand breeding programs, teasing of females is beneficial, but requires individual interpretation of behaviour of the female and male. Professional involvement can be beneficial, particularly for the problem breeder. Rectal palpation alone, but ideally in conjunction with ultrasound, will enable monitoring follicular development to predict the correct time for matings.

The approach to rectal palpation is basically no different to that in the mare or cow, however size disparity of the operator's hand and rectal sphincter, as well as pelvic cavity contents may preclude any other factors. In addition, however, consideration must be given to restraint, lubrication, behaviour of the animal and client acceptance of the procedure. The rectum of the llama is comparable to that of a mare, requiring gentle well lubricated examination procedures. For the intractable individual, torbugesic (.02-.04 mg/kg IV or IM) has proven to be very helpful.

Following a breeding resulting in an induced ovulation and beginning corpus luteum development, a female llama will behaviourally refuse any further matings. The combination of reduced oestrogen and rising progesterone

levels in her blood apparently accounts for this behaviour change. Confirmation of pregnancy can be accomplished at virtually all stages of established gestation via various techniques, and depending somewhat on management as to applicability and interpretation. Persistent behavioural refusal on the part of the female from 14 days post breeding is very encouraging and should preclude other approaches. Transrectal ultrasound detection of pregnancy has been observed as early as at 12 days of gestation, however a practical time for the determination should occur at 21 to 28 days, when the foetus and heartbeat can be readily detected. An advantage of early ultrasound determination includes accurate estimation of gestation stage, in spite of unobserved pasture breeding activity. If dealing with alpacas, or maiden llamas, an adaptor to the transrectal ultrasound transducer will allow early pregnancy diagnosis. This technique requires intrarectal lubrication and a tractable, restrained animal. Blood progesterone determination to date requires a commercial laboratory as no test kit has proven to be reliable in llamas. In addition, to accurately interpret progesterone results, the female subject must not be in contact with a breeding male for 14 to 21 days since the previous breeding/refusal as she may have been rebred and already into a second luteal stage which would be indistinguishable from a pregnancy. The necessary turnaround time, and possibility of a retained corpus luteum are additional disadvantages of progesterone analysis.

Transabdominal pregnancy diagnosis can be successfully accomplished in some females as early as the 35th day of gestation from the left flank fibreless area of the body. As the pregnant uterus becomes more gravid, it will shift position such that by 90 days of gestation it will reside toward the right side. While the foetus will not always be readily detected, healthy appearing fluid and membranes will generally confirm a sustained pregnancy.

Rectal palpation alone can be used to confidently diagnose pregnancy in maiden females as early as the 30th day of gestation, however many will be difficult to enter due to size disparity. Because of residual asymmetry of uterine horn size from the previous pregnancy, a veteran female will be somewhat difficult to confidently deem pregnant until 45 days of gestation. After 90 days of gestation, the gravid uterus becomes difficult to palpate and pregnancy is suspected due to cervical position and tone as well as inability to locate a nonpregnant uterus. Reconfirmation of pregnancy status sometime after 60 to 70 days is recommended as the period 30 to 60 days appears to be the prime time for pregnancy resorption.

Fertility/infertility workups for male and female llamas involve techniques that have been adapted from other species. Detailed descriptions of semen analysis, vaginoscopic, uterine biopsy and uterine culture techniques are to be found elsewhere.9,11,15 In addition, aspects of abortion causes, diagnostic and therapeutic approaches are discussed in detail.

Neonatal Care

A minimum of professional attention to the llama neonate includes a thorough physical examination with emphasis on cardiac auscultation, evaluation of umbilicus for hernia and adequacy of disinfection, determination of freedom of congenital defects, assessment of vigour and determination of maturity status. A more aggressive approach will include determination of a hematocrit and total protein for establishment of normalcy prior to assessment of adequacy of colostral passive transfer at greater than 24 hours of age. On premises known to have had a problem with type C enterotoxaemia, camelid neonates at birth have been administered up to 20 cc of C/D antitoxin subcutaneously with no deleterious effects. As a follow up evaluation for neonates that are deemed suspect of passive transfer failure, a repeat of the hematocrit and total protein determination is to be made. Normal neonates at 24 hours of age will show a slight reduction of hematocrit from birth and a rise of total protein from generally less than 5.0 gm% to greater than 6.0 gm%.

While the total protein determination is not as accurate as electrophoresis or llama specific radial immunodiffusion techniques for estimating globulin content, the practicality of it makes it worthwhile as a rapid screening method. While various other tests for globulins, including sodium sulfite (Llama-S)a and zinc sulfate turbidity have been used, we will only be accurate in our estimates when llama globulin specific tests are used.b Neonates falling into the obvious or suspicious category of failure of passive transfer should receive transfusion of plasma from a healthy donor or frozen plasma bank. As a practical guide, normally hydrated neonates having a 24-36 hour total plasma protein of < 5.0 should receive 8 to 10% of their body weight in plasma either intravenously or intraperitoneally. A veterinary practice is an ideal pivotal point for establishment of a plasma bank as well as a colostral bank. Client education on quality first milking colostrum of ideally caprine species origin is often necessary as only in the case of stillbirth is there any llama colostrum to be spared for future neonates. Goat owners should be instructed to vaccinate their does prior to kidding with Clostridium perfringens C/D toxoid as well as tetanus toxoid and only provide first milking colostrum to the colostrum bank.

Immunisations

Particularly in the area of immunisations do we currently observe the influence of a consulting veterinarian’s background and other species orientation. No vaccines are officially approved for use in camelids. Without vaccination studies followed by serology and challenge procedures, little can be said with confidence about efficacy, duration of immunity, and frequency of vaccine administration. At best, vaccination decisions are currently made on the basis of theoretical indications and minimal observed complication risks, and are administered using dosages, routes and schedules derived from other species.

An effort should be made to coordinate the herd immunisation program with the herd deworming schedules. Solid immunity to Clostridium perfringens C/D and tetanus should be a minimal goal in all llama herds. Llamas have been shown to develop specific antitoxin response to Clostridium perfringens C/D4 and Clostridium tetani14 toxoid vaccinations. Thereafter local and herd health problems based on opinion of the attending veterinarian should be considered.

As such, the following minimal recommendations and options are offered as guidelines:

- Annual C/D/tetanus toxoid for all juvenile and adults (3 cc of toxoid SQ). It appears titers return to prebooster levels within 60 days, making it unclear as to when to rebooster the herd
- C/D/tetanus booster to pregnant females one month prior to anticipated birthing
  Note. While there are 7-way/8-way clostridial vaccines, they are observed to cause significant injection site reactions in llamas and some correlation with post injection abortions is emerging.

Neonates

On enterotoxaemia-endemic premises, 20 cc of C/D antitoxin (10 cc – 2 sites SQ) at birth independent of dam's vaccination status and colostrum intake. It appears that the camelid neonate is immunocompetent at birth (Johnson L.W. et al, unpublished observations). Independent of antitoxin administration and colostral intake, active immunisation efforts have been initiated during the first week of life followed by two monthly boosters. Thereafter they are annually boostered with the herd.

Immunisation Options

- In leptospirosis-endemic areas,6,7 biannual vaccination of brood females should be considered using multivalent products available for other domestic species, once before breeding, once mid gestation
- In rabies-endemic areas,13 annual vaccination with a killed product should be considered
- If risk of snake bite is real, annual vaccination for malignant oedema may be justified
- If close association with genus Equidae is likely (especially zebras), vaccination with EHV-I killed vaccine quarterly should be considered
- If theoretical indications arise to use vaccines against any viral infections known to be a problem in other species, it would seem wise to avoid any modified live products until experimental work dictates otherwise. The only exception to that recommendation would be use of parainfluenza-3 (PI3) vaccine intranasally as an attempt to alleviate chronic nasal discharge in young llamas
- As an effort to provide colostral protection to the neonate, ScourGuard-III® has been administered to pregnant llamas without deleterious effects to the dam
- CalfGuard® has been administered to newborn llamas on premises having significant diarrhoea incidence with subjectively assessed benefit
- Sheep abortion vaccine has been used in llama herds where abortion/stillbirths due to Chlamydia sp have occurred. No adverse reactions have been observed and a good serological response was detected due to the vaccine

Nutrition

Knowledge for solid nutritional recommendations is sorely lacking for maintenance, growth, gestation, lactation and work considerations. However, a veterinary practitioner can provide valuable guidance for most llama owners using general nutritional knowledge of quality forages and careful scrutiny of supplements. It is important to bear in mind that llamas, like their progenitors, the wild guanacos are adaptive animals, being able to build body stores during high caloric and protein intake which are utilised during the less nutritionally favourable times. In the North American management scene, most llamas are being offered a high plane of nutrition the year around, making many considerably overweight, and unlikely to take advantage of their outstanding ability to re-utilise urea for protein synthesis. The point of this information as relates to a herd health program is that a veterinarian can aid in selection of quality grass hay of 8 to 10% protein which will serve as the basis of herd nutrition. Core sampling and submission for nutrient analysis including selenium is encouraged.

Thereafter, protein supplementation using quality alfalfa hay for select groups including weanlings, late gestation and lactating mothers could be considered. Provision of a salt/mineral supplement is all that is additionally necessary. Table 1 indicates the nutrient contents of a basic maintenance forage diet for a mature llama and a mineral supplement (Table 2) that could be offered free choice. An option for the mineral supplement involves the inclusion of additional selenium (90 ppm) and vitamin E (8000 units/lb) for use in areas that are considered deficient. This mineral mix could be bulk mixed, packaged and made available to llama clients. Periodic blood sampling of the herd or peer groups for routine blood biochemical profiles including selenium, copper, zinc and iron are recommended. Major alterations from published normal values5,9 would deserve mineral supplementation consideration.

Table 1: Basic forage diet analysis for maintenance feeding of llamas (dry matter basis).

Nutrient	%	Nutrient	ppm

Protein	10.00	Mn	50.00
Fat	2.00	Cu	7.50
Fibre	30.00	Co	0.65
TDN	55.00	Zn	35.00
CA	0.65	Fe	100.00
P	0.35	Mo	2.50
Mg	0.25	Se	0.35
K	2.00		
Na	0.25	Vit A-20,000 units/kg	
S	0.21	Vit E - 25 units/kg	

Consultation with owners on the subject of a growing number of llama supplement options can be both frustrating and rewarding. If one embraces the concept that these animals are adaptive to seasonal nutrition changes and that they are basically browsers and grazers, then significant levels of supplementation via pellets or cereal grains is likely unnecessary. As such, only nutritionally debilitated and animals subjected to extremely cold climates likely need caloric supplementation. As mentioned previously, protein supplementation can be provided by quality alfalfa hay. Therefore, the only consistent justification for supplements may be in the area of micronutrients, especially selenium. If a palatable low energy, low protein, high fibre pellet can provide 2 mg of selenium/100 kg of body weight and the amount consumed is no greater than 10% of anticipated dry matter consumption, it can perhaps be justified. As such, a 150 kg (330 lb) llama should not be consuming any more than 300 gm (2/3 lb) of pelleted supplement per day. A free choice salt mineral mix remains as a viable option.

It appears that there is rising scepticism concerning the use of injectable vitamin E/selenium preparations prophylactically. Concerns over safety for use in pregnant females as well as in the neonate are foremost. In addition, the relatively short duration of elevated blood levels of selenium achieved following parenteral injections indicate this procedure alone is not adequate. Consequently, oral supplementation via free choice mineral mixes or palatable pellets would seem to be a better alternative.

Table 2: Composition of mineral supplement to be offered free choice for all ages of llamas.

Bone meal	25 lbs
Dry molasses	50 lbs
Monosodium phosphate	25 lbs
Trace mineralized salt	50 lbs
ZinPro® 100	10 lbs

Another area for veterinary involvement in nutrition is to assist in establishment of feeding groups. During any procedure, an attempt should be made to offer a subjective evaluation of body condition. This can be done using a 1 to 10 scoring system whereby 1 designates very thin and 10 designates very fat, with a score of 5 being ideal. Once body scores are established, animals of similar body condition in similar peer groups are fed together. The fact that this can perhaps be done without bias by an attending veterinarian makes it quite owner acceptable and is appreciated.

Procedures

Consistent with the variation of backgrounds of llama owners will be the variation of their involvements with techniques including injection and deworming procedures as well as removal of fighting teeth. Consequently a veterinarian should attempt to evaluate the need to be totally involved, or strictly serve as a consultant. Except for occasions when a rapid attainment of drug blood levels is required, the subcutaneous route for parenteral administration has proven to be minimally invasive but effective in llamas. Preferred sites are more ventral locations in front or back of the shoulder where up to 15 cc/site have been administered without problems. Oral paste dewormers and drenches are readily used with paste dewormers preferred. When Ivermectin is deemed the desirable dewormer, the parenteral product (SQ) is preferred. The topical IVOMEC® designed for cattle has been utilised for llamas with encouraging results and no adverse reactions.10

Fighting teeth removal

Male llamas will generally need to have their fighting teeth cut by 2 to 2.5 years of age. While numerous procedural options exist, cutting the teeth at the gum line with obstetrical wire has emerged as the simplest and least invasive and accompanied by minimal complications. Ideally this should be done when all six teeth have erupted (between 2-3 years of age).

Since many clients would prefer this procedure performed under anaesthesia, it could well be combined with gelding surgery. Without anaesthesia, the procedure is best accomplished in a restraining chute8 where the animal is cross-tied and an assistant props the mouth open (torbugesic at 0 .02-0.04 mg/kg IM provides excellent sedation). A spray gun or water filled syringe is used to cool the wire. To reduce spread of disease, a new piece of wire should be used for each animal.

Gelding

Under normal circumstances, it appears the ideal age to geld a llama is after two years of age. As with other species, this age decision is debatable. An anaesthesia period of 20 to 30 minutes can be achieved by administering a ketamine:xylazine (10:1) mixture intramuscularly at 4.0 mg/kg ketamine and 0.44 mg/kg xylazine. The castration procedure is analogous to that performed in the horse, with minimal observed complications of swelling or infection.

Parasite Control

New World camelids are subject to infestations of both internal and external parasites. As regards internal parasites, it would appear that virtually all nematode parasites known to affect cattle, sheep and goats are capable of infesting llamas while the protozoa coccidia remain species-specific. The migration of larval forms of the meningeal worm Parelaophostrongylus tenuis is a constant threat to llamas living in areas inhabited by white tailed deer. Liver flukes are a problem in the same geographical areas as for traditional ruminant species. Tapeworm segments are occasionally passed in faeces making for principally aesthetic concerns. Toxoplasmosis does account for occasional abortions, and many llamas appear to be seropositive. Over the past two years, a significant incidence of blood parasite Eperythrozoon spp has been demonstrated in llamas, most often affecting immunocompromised individuals. With the common usage of ivermectin, the incidence of mange in llamas is extremely low, however considering their habits of using a community dusting area, it remains a constant possibility. There is in addition a need to regularly monitor the presence of both biting and sucking lice in these long fibred species. In certain geographical locations, ticks will seasonally be a problem causing the occasional case of tick paralysis.

Depending on many management factors, including geographical area, numbers of animals, groupings of animals, and pasture rotation/degree of confinement, a parasite control program should be tailor-made. Many llama owners have been led to believe that llamas are virtually parasite-free owing to their tendency to use a communal dunging pile. Faecal examinations of individual or composite samples from llama groups will generally allow interpretation of current parasite concerns. All animals in the groups should be wormed at the same time. Most nematode parasites have been controlled using fenbendazole preparations (paste or drench). When Nematodirus spp or Trichuris spp are diagnosed, up to three times the normal dose is used with effectiveness and safety. Tapeworms are also markedly reduced by these higher doses, however albendazole appears to be more effective. Demonstration of fluke eggs will necessitate use of clorsulon for control. As with other species, demonstration of coccidia oocysts is common and elicits variable responses from owners and veterinarians. Unless an animal is stressed by other factors, we rarely observe clinical manifestations associated with coccidiosis. Consequently, most control measures are aimed at minimising the problem in recently weaned youngsters with either decoquinate or amprollium and allowing them to develop immunity. Clinical cases are generally responsive to parenteral sulfadimethoxine.

Intervals between deworming procedures will vary principally with age of group involved, degree of confinement, annual rainfall of environs, and the parasite problems at hand. Breeders having to deal with the meningeal worm problem are often found to be administering the parenteral ivermectin preparation at 21 to 30 day intervals. Under this scheme, most other nematodes should be controlled. Periodic faecal exams would be indicated however, to monitor any development of resistance. In dry environments, a minimum of two deworming procedures per year is recommended. A springtime deworming should take place before the animals go on pasture using a product directed at nematode control. A fall deworming, one month after a killing frost, with an injectable ivermectin would have an impact on nematodes as well as have a theoretical benefit to reduce nasal bots. If nasal bots are strongly suspected, a double-triple dose of injectable ivermectin has been observed to be more effective. Those in traditionally heavy parasite load locales should consider two or more additional dewormings per year, ideally, coordinated with pasture rotations. With considerations of parasite resistance as well as available anthelmintics, rotation of products is a consideration. Table 3 lists various anthelmintic and coccidial drug options.

Table 3. Anthelmintics.

Fenbendazole	(Panacur) (Safeguard)	11-15 mg/kg (O) 1-3 days
Ivermectin	(Ivomec)	2 mg/kg (SQ) 1 day
Thiabendazole	(Omnizole)	55-110 mg/kg (O) 1-3 days
Levamisole	(Ripercol) (Levasol)	5.5-8.5 mg/kg (O or SQ) 1 day
Mebendazole	(Telmin)	22 mg/kg (O) 3 days
Albendazole	(Valbazen)	6.5 mg/kg (O) 1 day
Clorsulon	(Curatrem)	6.5 mg/kg (O) 1 day
Praziquantel	(Droncit)	2.2-3.3 mg/kg (O or SQ) l day
Pyrantel pamoate	(Strongid-T)	8.5 mg/kg (O) 1 day
Coccidial drugs		
Prevention		
Amprolium	(Corid)	5 mg/kg 21 days (1.25% crumbled in feed or 9.6% solution in drinking water)
Decoquinate	(Decox)	0.5 mg/kg 28 days

Therapy	
Sulfadimethoxine (Albon)	Day 1 - 55 mg/kg (SQ) Day 2-5 - 22.5 mg/kg (SQ)

Recommendations for the prevention and control of eperythrozoonosis in llamas remain empirical and untested. At this point, it appears there may well be significant numbers of potential carrier animals in the camelid population, such that emphasis in prevention should be aimed at minimising vector possibilities. As such, lice, mites, biting flies, gnats, midges, mosquitos and ticks should be controlled. In addition, emphasis should be on good hygiene for any needles, syringes, tattoo pliers or other equipment that could potentially transfer infected blood. Blood donor animals for plasma or whole blood should ideally be free of the parasite. The problem, as of this writing, is to be absolutely sure of who is negative. Careful study of freshly made blood smears from animals that are borderline to severely anaemic is recommended. In addition, serologic testing using an ELISA© test would appear to be the most rewarding procedure. Clinical cases have improved using oxytetracycline therapy (Table 4), however recrudescence 2 to 3 weeks following treatment is predictable if the animal is immunocompromised.

Ectoparasites of principle concern in llamas include mange, mites, and biting or sucking lice. Monitoring new additions to a herd including visiting breeding animals will minimise chances of introducing the problems. Lice can generally be demonstrated by parting fibre over the dorsal midline from shoulder to rump and using close inspection with the naked eye or a hand lens. It is important to determine whether the lice are biting or sucking varieties. Ivermectin will generally be effective against sucking lice (Microthorcis cameli), however only minimally effective for biting lice (Damalinea breviceps). Both biting and sucking lice will be effectively treated using a 3% fenthion (Tiquvon®) product as a pour-on administered at 31 cc/100 kg in direct contact with the skin through parted fibre on the dorsum of the back. Permectrin (Ectrin®) is another pour-on option that has been reported to be safe and effective.

While llamas seem to have unlimited possibilities for dermatologic problems, mange remains a differential diagnostic consideration for any hyperkeratotic/ parakeratotic lesion. Conventional skin scraping techniques will usually demonstrate the mites. Sarcoptic, chorioptic, and psoroptic mange have all been diagnosed. Generally one can anticipate a favourable response from parenteral ivermectin therapy (0.2 mg/kg SQ), however in the case of chorioptic mange, increased dosages appear to be indicated (0.4 mg/kg SQ). Repeating the administered dosages 21 days later is also recommended.

Table 4. Eperythrozoon therapy.

Day 1	11 mg/kg oxytetracycline (IV)
	20 mg/kg oxytetracycline (LA-200 SQ)
Days 3, 6, 9, 12	repeat La-200 above
Days 15-50	Aureomycin pellets @ 22 mg/kg

Tick control is as frustrating in llamas as in any other species. Use of parenteral ivermectin during the peak tick season should minimise chances of tick paralysis. Ectrin® spray has been observed to be of value when repeated as a total body application on a 5 to 7 day basis. Avoiding heavily tick infested areas in the spring of the year is likely the most effective recommendation.

Measures to prevent, control and treat toxoplasmosis in llamas is essentially no different than for any other species. Prevention is aimed at minimising exposure to infective oocysts on the premises. This is best accomplished by maintaining a minimum cat population and at least keeping only mature cats that will shed minimal numbers of oocysts.

As such, reminding llama owners of this relationship and encouraging good hygiene including attention to cat litter boxes should be part of a llama herd health program. There is essentially no economical effective treatment for animals infected with toxoplasmosis.

State of the art record systems are slowly being developed modelled after other species, but with emphasis on reproductive parameters, vaccinations and deworming schedules. These also can be tailor-made to suit the client's goals and needs.

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