ALPACA FIBRE PROJECT

The objective of this study was to develop a systematic fleece handling and storage procedure prior to processing that can be adopted by the producers and processors to maintain fibre quality. It included:

1. Literature review.
2. Staff and fibre producers training.
3. Data base development - Processing equipment and manufacturers list.
4. Data base development of large scale mills appropriate for processing alpaca fibre that can be obtained/built economically for use in Canada and for this project.
5. Research on Fibre Storage, Washing/Cleaning, Drying, Processing - “Train interested fibre producers/individuals/groups”.
6. Data base development “Fibre Market information based on literature review”.
7. Outline of curriculum for BIO 898 Fibre Processing & Biocomposites course at U of S regarding sorting, storage, washing, drying, blending and processing.
8. Methodology Booklets reporting the practical findings from this Project to help individual alpaca breeders develop best practices to get the most from their annual fibre harvest in the areas of Fibre storage; Fibre cleaning/washing; Fibre drying and Fibre Processing.

Thank-you to our Research Scientist Dr. Satya Panigrahi, and Supervisor Dr. R.L. Kushwaha. Thank-you Saskatchewan Alpaca Breeders for supporting this project with your fibre. Alpaca Fibre Booklet is a result of this Project and industry proven best practices and is published with permission of Dr. Satya Panigrahi, and Supervisor Dr. R.L. Kushwaha.

Thank-you to the SABN Fibre Committee. For some it was your efforts to get this project off the ground in 2010, and for others your dedication to see it to completion in 2013. Congratulations, perseverance has resulted in exciting potential developments in our alpaca fibre industry!
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### Processing Notes

Processing findings from this research were limited to the production of rovings. Some blending was done and blends of alpaca with silk, bamboo, and flax improved the carding process.

This research has confirmed the value of sorting and classing alpaca fleece in the overall production of a quality product. In order to create a uniform raw material that can be used in textile industrial processes, the alpaca fibre must be sorted and classed before processing. To efficiently run the equipment and produce a quality product second cuts must be eliminated.

Use of a tumbler for a brief amount of time—5 min to 45 min max depending on how fine or how dirty the fleece is as well as the quantity of fibre—serves to remove vegetation and dirt still in the fibre after washing and drying. Care must be taken when tumbling finer fleeces as fibres may stick together creating a spinning process instead of a tumbling one.

Conditioning solution sprayed on the fleece after going through the picker should not exceed 2% of the weight of the fleece in a batch or machinery gets "gummed up". The conditioners protect static charge, soften the fibres and strengthen bonds between individual fibres which improves processing.

Fibre that has been washed and dried effectively is the biggest factor in ease of processing.

To see a current list of Mills in Canada see [www.sabn.net](http://www.sabn.net).
**Microwave Drying (not recommended)**

This method could feasibly dry alpaca fibre using a maximum power of 400W. Experimental fibre dried to almost 0% in 5.5 minutes. However this is not recommended at this time as a proper design and temperature control are needed to avoid hotspots and fibre degradation. Color analysis experiments indicated discoloration of the alpaca fibre started around 130 degrees C. With the proper design and temperature control it is feasible to implement microwave drying alpaca fibre in the future due to the shorter time and less energy requirements.

**Thin Layer Drying (not recommended)**

This method was found to be inefficient in terms of time. Time was reduced when temperature was increased however the quality of the fibre at higher temperature was not acceptable in terms of gloss, (lustre) and smoothness. The fibre dried at higher temperatures resulted in breakage during processing.

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**The What and Why of Alpacas**

Alpacas are camelids, domesticated over 6000 years ago in South America, mainly Peru, Bolivia and Chile, where they were considered national treasures. Descendent of the wild Vicunas, alpacas have traditionally produced an ultra luxurious fleece that was crafted into exquisite cloth, used as currency and known to be exclusive to ancient royalty. Since the early 1990’s alpaca farming has spread to nearly every continent on the earth, stretching from Australia to Alaska. The vast scope of variations presented by the alpaca industry, from environmental influences to fleece characteristics create unique challenges in establishing standards and best practice methodologies for producers and processors of alpaca fibre. Quality assured fibre production is key to a successful alpaca industry.

The 2013 Canadian Llama Alpaca Association statistics indicate 29,088 alpacas are registered in Canada. Producers shear their coats annually averaging approximately 5lbs/alpaca/year providing an approximate annual Canadian harvest of 145,000 lbs of alpaca fleece that could potentially be converted into high end fibre products.

Because a true full scale commercial fibre industry requires much more volume and consistency than we are able to produce in Canada today, we are challenged to create our own small scale successes. Potential production from one alpaca (4.5lb.—5.5lb.) could include

- throw ¾ lb (340gms) $100. - 200.
- hat, mitts, scarf 1lb (450gms) $100. -150.
- 6pr insoles wool blend ¾ lb (340gms) $ 60. - 100.
- 4.5pr socks 1lb (450gms) $137-180.

What are the best practices to most efficiently get this fibre from the farm into consumers’ hands? This research project experimented with fibre storage, washing, drying and some processing to develop and recommend economical, feasible best practices for small scale alpaca breeders and millers in an effort to help maintain alpaca fibre value through processing to the high end product market.
Introduction to Alpaca Fibre

Alpaca fleece is a protein based fibre. This protein called Keratin is heat sensitive and should be handled/processed in a way to protect the internal and external structure from damage, dehydration, and shrinkage. Although the alpaca is regarded as a rare, luxury type of specialty fibre in the textile industry, most processors are adopting methodologies used for wool even though the surface characteristics vary. Alpaca is a dry fleece with little or no lanolin or grease as found on sheep’s wool and is hypoallergenic. Alpaca fibre has a very low scale structure which gives a slippery feel. Wool has a raised scale structure and feels pricklier. Alpaca clothing has a softer feel than a finer micron wool garment, even when they have the same twist of yarn.

The physical properties of alpaca fibre that determine the end use and value of a fleece are:

- fineness (average fibre diameter),
- staple length,
- brightness,
- medulation,
- color,
- uniformity of character and crimp.

The fineness of Alpaca fleece is measured by the average diameter of the fibres. This measurement is recorded in microns. 1 micron =1/1000 of a millimetre. Alpaca fibre ranges from 15 microns to greater than 35 microns. Finer fibre is used in garments to be worn next to the skin. Coarser fibre is used in outer garments, felting, batts and rugs or articles of home décor.

It is difficult to fully utilize alpaca fibre due to the lack of production volume in Canada and the lack of available optimal production standards and procedures for mechanical processing of alpaca fibre. Alpaca farming is for the most part considered to be a cottage industry. This project attempted to develop a simplified system where farmers can wash, dry and store their annual fleece harvest, to maximize return and prevent deterioration, prior to sending fleece to the mills.

This is the recommended method. It’s simple, easily built at a low cost and can be adapted for small scale producers to large processing mills.

- Alpaca fibre should dry in a steady temperature range from 30 to 50 degrees C. so internal composition, tensile strength and glossiness of the fibre is maintained and fibres moves efficiently through the mechanical processing.
- Drying should maintain internal moisture content of 8% to 12 % which is appropriate for mechanical processing.
- During this process the moisture is reduced to an acceptable level within an acceptable time. During the research, after 6 hours of drying moisture was 12 % (wet basis) at 35 degrees C and 10%(w.b.) at 50 degrees C.

The Dehumidification process of alpaca fleece is a potential drying system to manage fibre quality in a well controlled drying regime and reduce energy consumption. SEM micrographs indicated the smoothness of the fibre sur-
Drying

Drying is an important process and a sensitive practice to maintain the proper quality with respect to the strength, colour, brightness and value of the fibre. Alpaca fibres, like most other animal fibre are protein based in nature. Fibre dries in two stages involving heat and/or air flow. The first stage is a constant rate transfer of moisture from the exterior of the fibre shaft and the second stage is a falling rate period that takes much longer for the moisture to transfer from the interior of the fibre structure.

Natural Drying Practice

Natural methods of drying fleeces have been practiced for ages and are to simply place wet fleece on a rack/rock and allow it to dry exposed to natural air, wind, sun. This method is suitable for very small amounts. It is not so suitable for larger amounts because it is not time or space efficient. Limited control of the variables such as temperature, wind, sunlight, humidity level and time leave this method somewhat undesirable even for a small scale business.

Three methods were studied in this Research Project.

1. Dehumidifier
2. Microwave
3. Thin-layer

1. Dehumidifier Drying (recommended method)

For this research project a simple industrial scale dehumidification drying cabinet was designed and developed to dry alpaca fibre by using commercially available dehumidifiers. It consisted of two drying compartments with 8 drying shelves and would accommodate 20 kg of wet alpaca fibre. The use of the drying compartment with the dehumidifiers allowed a large amount of fibre to be dried at regulated temperatures. The dehumidifying capacity of the chamber was 19 L of water per day with power rating 2x424 W, condenser pressure 2x2.03 MPa and evaporator pressure 2x 0.97 MPa. Thermocouples were mounted to measure air temperature. The relative humidity was measured using RH sensors located in the dehumidifying chamber.

Effects of Nutrition/ Stress on Alpaca Fibre

Healthy fleece from a well nourished and content alpaca is bright and strong. A fleece that breaks easily is called a tender fleece and indicates stress at some point in the year’s fleece growth. Tender fleeces should not be used in yarn production. It can be used for felting or stuffing. Dull, chalky fleeces can indicate health issues and do not have that beautiful soft handle characteristic of a healthy alpaca fleece.

Preshearing Tips of the Trade

1. Feed alpacas so they do not pull feed down onto their backs or necks or can not get their heads deep into the feed.
2. If possible keep alpacas on green grass for a week prior to shearing. Ensure dust baths are clean and pastures are not contaminated with sticky type seeds.
3. If bedding is still necessary, fresh straw, or green feed bedding is easiest to clean out of the fleece.
4. Cleaning the fleece should be initiated prior to shearing and may take 5 to 30 minutes per alpaca.

Various methods used by some producers include:

- commercial blower or industrial shop vac to blow dust and vegetation from the fleece. Care must be used not to tangle the fleece. This method does disturb the character and crimp of the fleece so should not be used for show fleeces. Alpacas should not be let back out into dirty environment before shearing as the fleece is blown open and is very susceptible to contaminants in this state.
- vacuum fleeces prior to shearing.
- smooth stick to gently rub and flick debris from the fleece.
- hand pick surface debris or gently rub surface with a micro fibre cloth.

A clean, organized shearing space is well worth the extra time and effort to create one, keeping in mind safety and an efficient traffic flow for alpacas and shearing crew.
Shearing Day Guidelines

1. Prepare a clean indoor space with sufficient room and lighting for safety, or order good weather for outdoor shearing.
2. Assemble crew of four to six people to efficiently perform the necessary tasks.
   - Alpaca Handler — gets alpacas cleaned, haltered, weighed and ready for shearing. A Shearer should never have to run after alpacas to get them on the table.
   - Shearer — keeps shears, combs, cutters working to ensure safety and efficiency while shearing.
   - Table Crew — keeps alpaca safe and steady on table or floor.
   - Fibre Dude — manages fibre from shearing to sorting tables.
   - Sorter (or Classer) — sorts, (classes) weighs, bags, labels fibre for storage, shipment and production.
   - Recorder — keeps production records.
   - Alpaca Handler — Weighs and returns alpaca to the barn.

3. Production Records
   - Good records enable you to make insightful and informed decisions in your fibre production and breeding programs.
   - Records you may want to keep annually include:
     - Incisor Teeth, Fighting Teeth (whether they were trimmed), Preshearing & Post shearing weights (to weigh right before and right after shearing gives you a total shear weight), Blanket weight, Grade (from Histogram or estimate), Staple length (from mid section), Guard Hair (None, Little, Medium or Heavy), Crimp (number of crimps/unit measure), Color (see CLAA color chart), Tender or Healthy fleece.
   - Labels for all bags of fibre. Proper labeling is an important step in proper record keeping, for your farm storage, as well as for shipping and processing. USE PROPER LABEL System.
4. Have an idea of what you want to do with your fibre. Research the possibilities before shearing to make your shearing day much more efficient as you can stream line your fibre into proper lots. If you don’t want the hands on approach to alpaca fibre production, contact a classer to discuss the possibilities for your fibre.

To find a list of current shearers, sorters and classers in your area, or to see a full updated Canadian Fibre Harvesting Code of Practice see www.sabn.net.

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The wash water temperature was adjusted by using a temperature sensor (thermocouple) attached to the bottom of the tank and the volume of the water was also increased or reduced based on quantity of fleece to evaluate the best washing conditions. The rinse temperature was not controlled.

The alpaca fleece does not contain lanolin or grease so moderately hot water around 35 to 50 C is a suitable temperature to wash alpaca without damaging the surface characteristics. This temperature is also sufficient to activate the surfactant in detergents to clean and wash the fleece.

Common Practice of Sink or Tub Washing

For those breeders that do not have access to this handy tank, any sink, bucket, or tub will work although not maybe so conveniently.

Fill a sink (bucket) with sufficient hot water (35-50 degrees C) to cover the fibre. Put the fibre in a basket, which is then put into the sink full of hot water and gently press the fibre into the water and allow it to soak for 30 minutes. The basket could be vibrated up and down to imitate the motion of the tank washer (if you are so inclined : )

The water is not stirred at any time to avoid felting of the fibres. A second bucket/sink is filled with clean hot water. The basket of fibre is removed from the first sink and allowed to drain until all the dirty water has run out. The basket containing the fibre is then immersed into the second sink/bucket of clean hot water and allowed to soak in the detergent for another 20 minutes before it is removed for the dirty, soapy water to drain. Repeat until water is sufficiently clear, before rinsing.

The process of rinsing the fibre is repeated several times in fresh water 30 to 50 degrees C. (This project did not research the temperature of the rinse water but used uncontrolled tepid tap water. Industry experience has recommended using the same temperature water for wash and rinse.)

The fibre can be carefully placed in a spinner to remove excess water prior to drying or simply allowed to sufficiently drain.
Washing

The processing begins by removing as much vegetation and debris as possible. Washing, popularly called scouring, is a vital step to clean the fibre of all impurities and unwanted materials prior to mechanical processing. It is simply immersion of the fibre into a solution of detergents and hot water. This research revealed that out of the 12 detergents studied Tide, Ultra Free, Baby Soft, Woolite, Purex, Cheer, and Sun Light made the fibre surface smoother, fluffier, reduced fibre entanglement, and was easier to process. There was no apparent degradation of fibre strength, handle or glossiness using these detergents. Degradation (thermal decomposition of keratin) started after 130 degrees C. Therefore washing, dyeing and drying temperatures of alpaca fibre must be controlled to avoid degrading the quality of fibre with respect to strength, glossiness or brightness and lustre, and discoloration due to excessive heating.

Research Tank Washing

A simple tank was built that can be reproduced on individual farms or this tank may be available for producers to use. (Contact SABN to inquire about it’s availability.) The washing tank is made of stainless steel with a depth of about 1m. The tank was filled about ¾ deep with 35 to 50 degree C water. Detergents were added and mixed properly to create a water solution concentration of 0.3% and 0.5%. The fleece was placed into the tank on the top of the table mesh that prevented the fleece from being entangled with the propeller. It was fully soaked. The propeller, made of 3 rotating blades was then turned on. The fleece was washed/vibrated up and down in a vertical manner efficiently washing it without matting. The dirty water was drained out of the tank. The tank was then filled with fresh tepid tap water with the fleece still inside and the rinse process was repeated two more times before the fleece was removed for drying.

Shearing Day Checklist:

- Alpacas can be kept dry
- Shearing area is ready
- Alpaca scale in place
- Shearing table, shears, sharpened combs and cutters, oil (chain saw oil works well), (your Shearer may supply these)
- First Aid kit ( blood stop, Magic glue, antibacterial spray, band aids, sterile gauze and tape)
- Dewormer, 8-way and sufficient sterile needles if you give shots while alpacas are on the shearing table— extra help to do this
- Toenail clippers, dentistry supplies (wire, side cutters, file, dremel tool, and diamond cutter, pipe or large rope to hold mouth open, paint stir stick to keep alpaca’s tongue away from the action)
- Hand shears to trim top knot and tail
- A few large old socks (over mouth and nose of the spitters) and rags (for the pee’ers— You don’t want wet fibre )
- Large mulch or garbage container for soiled/unwanted fibre
- Calibrated fibre boxes or baskets to transport fibre from shearing table to sorting table— Same size laundry baskets work great
- Fibre scale in place
- Sorting table and area are ready
- Clear plastic garbage bags set up in sufficient bag holders strategically placed for good traffic flow. Enough extra bags
- Labeled ziplock baggies/paper work for fibre samples
- Ruler for measuring staple length from cut end to tip
- CLAA Color chart
- Farm shearing record sheets, pens
- Markers and pre-made labels to identify each bag of fibre (If fibre is classed by certified classer they will bring classed bag tags and Shearing day record sheet )
- Food and Drinks for your help
- Smile! Your annual harvest will soon be ready for production

To download sample forms go to www.sabn.net
**Sorting the Fleece**

- Sorting is an important step to maximize fibre production.
- From the shearing table fleece is laid out on a sorting table top of metal grate or wire mesh with 1/2” openings for 2nd cuts and debris to fall through.

- Sorting is the practice of separating the fleece by its natural divisions along body lines - longer from shorter and finer from coarser.
- Keep in mind fibre varies on every alpaca so the following is a general guideline. Set up a minimum of 5 clear bags for each alpaca sheared.
  1. Lower leg, britch, soiled fibre (Mulch, Trash)
  2. Belly, apron, Coarser fibre (Mulch, Felt, Rug)
  3. Blanket (Prime Fleece)
  4. Skirtings (Off sorts from Blanket)
  5. Neck (Shorter than blanket)
- Use your best effort to eliminate 2nd cuts, vegetation, matted or felted fleece, and urine/dung contamination.

After sorting the fleeces, they should be cleaned by using a tumbler and high speed fan to separate more dirt, vegetable matter, second cuts and guard hair from the fleece. This practice also dries it before storage.

**Classing the Fleece**

A certified classer can be called to class your fibre on shearing day, or to class your sorted fibre some time after shearing. They bag together similar fibre according to grade, length and color from multiple alpacas making large uniform lots of fibre, thus increasing milling efficiency and product quality, while decreasing cost of production. Classed fibre ensures repeatable quality assurance.

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**Post Shearing Fleece Handling**

Although most producers prefer to ship their fleece to a mill shortly after shearing, this study found that a majority of fleeces were stored between 6 and 20 months between shearing and production. This research found that improper storage led to moisture, mildew, fungus, mold, insects and/or rodent problems causing deterioration of fibre properties and color that resulted in machinery problems and inferior end products.

If a producer stores freshly shorn fleece in closed plastic bags excessive moisture and heat can’t escape leading to degraded, smelly fibre. This research concluded that for long term storage, best practice would be to properly wash and dry the fibre, then store it in a clean, well dried state. Although a great concept this is not practical for many alpaca producers. Because proper storage IS critical and applies to all alpaca fibre producers, storage is reported on first.

**Storage Recommendations**

Within 5 – 7 days after shearing

- Clean fibre by tumbling, picking, or washing
- Dry all fibre before storing it using fans and/or dehumidifiers
- Store in perforated plastic bags, preferably LLDPE Bags (most regular kitchen garbage bags) or Cotton bags with desiccant (available at stores listed below)
- Store bags inside corrugated cardboard boxes (min.3 ply)

**Storage Materials**

- LLDPE, liner low density polyethylene, bags must be perforated to provide proper air flow allowing moisture to evaporate. These bags exhibit high resistance to puncture, moisture, bacteria, environmental stress, fungus, molds, UV, chemical and low temperatures, also a high degree of flexibility, stretch and high oxygen index.
- Vacumed PP bags for longer storage. (Available at Canadian Tire, Walmart, Rona, Home Depot, Superstore etc.) Producers can use their own vacuum cleaners to vacuum seal the bag.
- Cotton bags/Pillow cases are safe for storage as they provide good ventilation.

Fibre can be safely stored at 20 to 35 degrees C at 55% RH for one year. Store in low light, low humidity area with NO direct UV rays. For long term storage pack fibre loosely inside bags to allow airflow. Store in a climate controlled storage if possible. ALWAYS label and document bags properly. Taking the time to do it right pays dividends.