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Llama Fibre:
Myths, Assets and Enhancements

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Abstract

Some negative characteristics of llama fibre may not be constant in every llama fibre used by the hand spinner. Some negative characteristics may be due to the selection of fibre, the cleaning of the fibre, the preparation of the fibre for spinning, the skill of the spinner or maybe a combination the aforementioned items. Part of the problem stems from the current lack of standardization in the fibre choices. Compared to alpacas and other fibre producers, llamas only recently became a popular fibre source for hand spinners. The natural characteristics of slippery fibres or fibres which lack elasticity may call on the spinner to blend the llama fibre with fibres with more tooth (that ability of a fibre to grip or cling to other fibres) or in the case of inelasticity, to blend the llama fibres with fibres containing crimp. Overall, many of the negative characteristics may be managed with experience in spinning many different fibres.
INTRODUCTION

After raising llamas for 30 years and taking spinning classes for over 25 years, I still hear negative comments about spinning llama fibre. My intention is to help other spinners understand and overcome certain negative factors. To do this, spinners must acquire knowledge on fleeces to recognize high quality as opposed to average or poor quality. They should also learn the process of cleaning and sorting fibres to save only the best for hand spinning, to prepare fibre for spinning using a variety of tools (combs, carders, hackles) for a given type of yarn, and to use the mechanical aspects of a spinning wheel as the primary tools for completing the objective.

My first llama (George Brett, a six-month old gelding with beautiful white fibre) started my journey into spinning. (see Appendix A, Illustration #2) A local spinner who raised sheep and spun for many years consented to teach me how to spin. Once I explained my desire to spin llama fibre, she furrowed her brow as she carefully explained to me it was spinnable, but only with wool added to it because it was so slippery. That first encounter with a negative reaction to llama fibre was a little discouraging, but made me determined to see if that assumption was true. It conflicted with the glowing reports about llama fibre I had read in llama journals such as - Llamas Magazine, Llama Life, Llama Banner. As a beginning spinner, I quickly discovered almost any fibre could be slippery. More practice spinning on my wheel with my most available fibre source made the spinning of llama fibre more controllable and actually comfortable for me. Later ventures into spinning classes introduced me to many new fibres like angora, rayon, tencel, and silk, making slippery llama a non-issue, except maybe to a new spinner. These classes also
instructed me in the processes of cleaning and carding the fibre, although I did not recognize the importance of those matters at that time; I just wanted to spin! However, I soon discovered that clean fleeces, commercially carded into roving made spinning the llama fibre even easier.

My second encounter with a negative attitude toward llama fibre came from a dear friend and spinning mentor filled with a wealth of knowledge about sheep, but not as much about llama fibre. She informed me that the llama fibre was inelastic, would stretch out of shape and would drape. (Is drape bad?) I was crushed by this new negative aspect, and wondered if this characteristic was confined to llama fibre. Drape was something I had not even considered since I was also a novice knitter. I followed up with more spinning classes to gain experience with other fibres. I discovered silk, ramie, mohair, linen, angora and cotton were just a few other fibres that shared the characteristic of inelasticity, but remained very popular fibres among hand spinners. My studies uncovered techniques to add elasticity through blending with crimped wool. According to Boeger (2007) the non-elastic characteristic is not that important in designer yarns.

The quest continued to find something positive about the beautiful llama fibre. Comments continued to be both positive and negative, but the negative remarks bothered me. Llama fibre is too short to spin, too scratchy, too coarse, has guard hairs, and is so slippery. Ignoring the negative comments was not going to change anything, so I set forth spinning llama as a novice spinner without a clear plan of analysis. This particular study is an effort to face the challenge to either support the negative aspects’ credibility or put all or some of them to rest. Do the negative characteristics reflect on all llama
fibre or may they also be attributed to a spinner’s inexperience in fibre selection, fibre preparation, fibre blending, or the actual skills of spinning?
A Short History of the Camelid Cousins

Surprisingly, the camelids (llamas, alpacas, vicuñas, guanacos, and camels) we know today began their lives in areas of the United States as long ago as 40 to 50 million years. Fossil records show evidence of this existence across extensive areas west of the Mississippi River. The Pleistocene epoch was a period of extreme cold and glaciations and it appears the camelids flourished during this time in our history. At the end of this period, the species that we later recognized as camels migrated over a land bridge connecting Alaska and Asia and have been domesticated for 4,500 to 5,000 years (Fowler, 1998, pp. 5-7).

The *llamoids* (forerunners of llamas, alpacas, vicuñas, and guanacos) migrated in a southerly direction, crossing the land bridge between North American and South America. Guanacos and vicuñas are considered the wild species of the group while llamas and alpacas are the domesticated species, having been so for 6,000 to 7,000 years.

The animals were very important to the Andean cultures as suppliers of meat, milk, fibre, and hides. They also provided dung for burning, were used as beasts of burden and were used in religious sacrifices (Fowler, 1998, pp. 7-8) (see Appendix A, Illustration #1). The guanaco is a large animal and although considered wild, is often domesticated. The guanaco has a brown upper body, neck and limbs with whitish fibre on the underside of the neck and a grey to black face. The fibre is 18 to 24 microns and the guard hair appears mostly on the bib and lower body.

Alpacas are the smaller, domesticated breed weighing about half as much as a llama and, over hundreds of years, have been bred for dense, fine fibre with few guard hairs. Chris
Switzer (1994) refers to alpaca guard hair specifically in the neck more than in the blanket, but also noted that this fibre is bagged separately when shearing. The Incas bred alpacas to have little or no guard hair (McCuin, 2009, p. 34).

Alpaca fibre is classed as huacaya, described as a dense, crimp, spongy fibre coat, or suri described as a long fibre with little crimp that hangs down in ringlets. Breeding practices of the Incas also produced a variety of colours in the fleeces (McCuin, 2009, p. 34). The alpaca registry today recognizes over 25 colours. Alpaca fibre ranges from 16 to 35 microns. According to Parkes (2007), the fibre is hair with a 4 ½ to 11-inch staple, no lanolin, some lustre, is hypo allergenic, absorbs moisture similarly to wool, and drapes. Alpacas have been used as breeding stock and show animals in the United States, but also are bred for fibre.

The vicuña is the smallest of the species and is wild. Historically the fibre was only worn by Incan royalty, often referred to as the golden fleece. The vicuña fibre ranges from 8 to 13 microns with guard hair only in the bib and lower body. These animals went through a period in history of being slaughtered for their valuable pelts. As the threat of extermination became evident from these practices, the government of several South American countries took measures to protect and preserve them, allowing fleeces to be shorn on a controlled basis. Vicuñas are only allowed to be exported to the United States when crossbred with alpacas to produce the Paco-vicuña. These crosses still have very fine fibre and offer more color variety than the tan vicuña. Paco-vicuña fibre ranges from 12 to 20 microns and is very expensive to purchase due to its fineness, warmth, drape, and very lightweight qualities.
Llamas are the large, domesticated species of the Andean civilizations and weigh 250 to 500 pounds, but may vary in size. They are found in many colors and fibre types. *Ccará* describes the shorter fleeced animal; *suri* describes the animals with straight fleeces; *huacaya* describes the animals with a more dense, double coat. The *huacaya* llamas may be short or medium woolled without much leg wool or face wool. The fibre grows outward from the animal giving the llama a fluffier look and may contain a lot or little guard hair. The *suri* llama fibre hangs downward in ringlets or waves and may be silky or coarse.

Llama fibre behaves like alpaca according to Parkes (2007). Llamas generally have guard hair which protects the undercoat. Parkes also indicates less guard hair is harvested through brushing rather than by shearing. Guard hairs must be plucked from the softer fibre to have a fleece that is not scratchy. Llama fibre ranges from 16 to 40 microns. Llamas from the 1980’s and before were generally used for breeding stock and as show animals. As the breeders’ market declined in the early 1990’s, an attitude for marketing fibre has developed. Some current llama breeders breed fine micron llamas to each other; some cross llamas with alpacas in an attempt for a more substantial fleece. Older llamas tend to have shorter fleeces and many continue to have a double coat with abundant guard hair and a softer undercoat.

I attended a lecture in 1987 given by Dr. Walter Bravo about llamas and alpacas. I learned llama and alpaca fibre were sorted and mixed in the huge sorting sheds of Peru. Soft fibre was called alpaca and the coarser fibre? You guessed it - llama! This labeling of llama as coarse (even though there would be some coarser alpaca tossed into that pile) has further added to the confusion and disinformation to many spinners. This mixed
sorting is also referred to by Robson & Ekarius (2011) by saying the llama fibre in the 20 micron range would be sorted in a pile designated as alpaca; alpaca fibre in the 30 micron range would be sorted into the llama-designated pile of fibre. It is much like using the name *camel* to describe a colour although there are various colours of camels.

Biologically, all of the species may be crossbred resulting in live births; however, it is a generally accepted belief that the crossbreeding of llamas and alpacas diminishes the quality of the animals. There are people who routinely cross llamas and alpacas hoping for smaller, woollier animals with very fine fibre. The animals derive characteristics equally from the two breeding partners, so it is often not the result desired. This cross is referred to as a *huarizo*, and is not a complimentary term.
Personal Perspective of the Llama Fibre Market

Llamas, in general have fibre that could range in length from three to eight inches and have a range of 16 to 40 microns. (Robson & Ekarius, 2011, p.378) Using this as a comparison of fibres from my herd in my analysis, I agree that some of my llama fibre is pretty short, but still not as short as some of the downy sheep fibre of one to three inches (Fournier & Fournier, 1995, Chapter 4) or cotton which may have a staple length of one half to three inches.

My older llamas fall into the classic style with an eye to balance (relationship of length of neck, body, leg positioning, sturdy structure, and banana ears) rather than fibre. In the late 1980's, the fibre was nice to look at, but in the breeders' market, the structure was all-important. My llamas display the double coats with an abundance of guard hair. Llamas which I have purchased or bred more recently have been with an eye toward finer, denser fibre. Because of its limitations, I handle my fibre with a system of diligent cleaning, sending nicer quality to a mill for dehairing, and sending very coarse fibre to be commercially woven into rugs.

Thirty fleeces that had accumulated in my basement were sorted, washed and many shipped to Texas for rugs; a few of those fleeces were retained for spinning fibre. A few years ago I might have declared all of them wonderful and perfectly suited to a spinner's basket. Knowledge is power, however, and I uncovered perfect examples of the types of fibre that perpetuate many of the myths and problems people have with llama fibre causing the beginning spinner to turn away rather than give llama fibre a second look. The intent and purpose of my study is to get spinners to think about the things they hear
about various fibres, to learn why those assertions are made, and to see if those assertions validate discarding certain fibres from the spinning repertoire. I also want those spinners to experiment with fibres, to try different techniques of preparation and spinning, and to try blending fibres to take advantage of the best positive characteristics of each one.
Grading Llama Fibre with Micron Testing

Merino sheep were brought to the United States and bred for standardization of the wool to the point that other sheep breeds use them as a standard. People may be generally aware that many sheep breeds have pretty reliable standards for wool staple length, crimp, fineness, but might not consider the possibility of those standards varying, too, as some sheep are sold to spinning flocks and bred to sheep of lesser quality, producing offspring outside of expected standards. With llamas there is no breed standard at this time; therefore the spinner must be aware of varying quality available in the fibre marketplace. Guidelines such as histograms and micron studies (see Appendix C) provide the most reliable guide to quality. Otherwise, the buyer must rely on acquired skills of hands-on examination of the fibre, or by buying fibre from trusted suppliers of high quality fibre. Serious fibre producers are learning about fibre grading and may spend a small amount of money to get accurate micron reading of individual fleeces.

Yokum-McColl Testing Laboratories provides these services for testing the micron count on various animals. Each species has a range of micron measurements expected for that species. Although llamas have an expected range of micron count, those statistics do not tell us about a particular animal. To understand the concept of the micron testing, let me explain more thoroughly. A sample of fibre from a given animal is sent to the laboratory (Yokum-McColl) to be scientifically tested. The test results are shown on a histogram giving the range of microns in that sample and where most of the fibres fall in the spectrum. A micron is $1/10,000^{th}$ of a metre. This may be hard to relate to, but think of the human hair, which according to Parkes (2007), generally has a range of 50 to 100 microns. The higher the number, the coarser the fibre; the lower numbers indicate a finer
fibre. It is very desirable to have llama fibres fall into a range between 16 to 24 microns for soft spinning fibre. Most fibre authorities discourage use of fibres with more than 30 microns for next-to-skin wear. More explanation of micron testing is provided in Appendix E with information directly from Yokum-McColl Testing Laboratories. I am providing histograms from a few different llamas just to show the micron variety one could expect to see when procuring spinning fibre (see Appendix C).

Llamas were shown and sold in the 1980s and 1990s without much, if any, consideration of microns, crimp or other characteristics of special interest to a spinner. In the late 1990s, members of the Missouri Llama Association encountered the idea of a fibre pool where they could send their fibres and receive yarn in return. All that was required was to remove as much guard hair, second cuts and vegetable matter as possible. No discussion ensued concerning fineness or crimp. One can only imagine the assortment in those hundreds of pounds of fibre received by the group of sorters and graders in the fibre pool. I wonder if people supplying fibre to that pool even considered the undesirable qualities of the belly wool or leg wool.

The Missouri Llama Association continued to generate interest in fibre for many members and invited geneticist, Dr. Julie Koenig of Corvallis, Oregon, in the early 2000s to speak on genetics and breeding practices relating to fibre characteristics. Dr. Koenig came to the seminar with histograms from Yoakum-McColl and samples of the finest llama fibre most of us had ever seen. She bred for fineness from 15 to 20 microns. Those attendees interested in using or selling their fibre took copious notes and asked in depth questions; others didn’t want to bother with the fibre and were only interested in
breeding correct (according to conformation, structure, balance) llamas that they could sell for breeding stock.

Since many of us shear annually, some of the downy undercoat does not have a chance to grow to longer lengths, but may be long enough to spin. Chris Switzer (1994) mentioned in her writings that some of the shearing was done every two years in Colorado. In Missouri, where llamas often suffer or die from heat stress due to the high humidity we generally experience, it is necessary to shear every year even at the prospect of lost fibre length. Waste portions of the fibre will be guard hair, the coarse fibre around the tail, leg wool, belly wool, and the line down the center of the back and the base of the neck that catches all the small vegetable matter that makes cleaning really difficult. Cria fibre is probably the softest ever available from the llama and is from the first shearing in animals up to one year old. This softness also makes the fibre some of the most difficult to sort and clean. The South American llama fibre was generally used for blankets and rugs with the guard hair not considered a problem. The guard hair and coarser hair provided long wearing items.

This may be the perfect place to discuss the difference between sheep wool and llama hair. According to Dr. Murray Fowler (1998), the term wool is properly used with the fibre from sheep. Sheep wool has minute surface scales and rarely contains a medulla. Llama hair is medullated except for the coarse guard hairs (Fowler, 1998, pp. 251-252). Llama hair has scales, but not as fine as those found in sheep wool. This is an on-going and often contentious discussion among members of the fibre community. To further confuse matters, alpaca fibre is referred to as alpaca and llama as llama fiber in South America (Fowler, 1998, p.251).
Taking the Negatives Aspects One-at-a-Time

Learning more about llama fibre to deal with negative characteristics and to adapt a variety of techniques of preparation, blending and spinning have become a metaphor in my life for other negative conditions and what impact learning and researching can have on life in general. First impressions often lead to misunderstandings and incorrect judgments.

All samples (see Appendix B) in my study have been spun on a Lendrum double-treadle wheel (see Appendix A, Illustration #3) using the three flyers to provide ratios ranging from 5:1 to 17.5:1 to apply for the necessary twist (Appendix A, Illustration # 4). All singles have been spun z and plied S for a two-ply yarn which is then wet finished. There are 39 samples of llama and other fibres for comparison and contrast in this study. In some instances, you will see some very nice llama fibre that exhibits the finer characteristics of llama fibre - soft, silky, and lustrous, even displaying some crimp. Other samples have been prepared to work with some of the negative criticisms - short, inelastic, slippery, and scratchy. Where llama fibre has been used alone or blended, woven or knitted samples have been provided suitable to the yarns. In a perfect world, all llama fibre would be crimpy and just the right length to spin in any style. Neither the world nor the fibre is perfect, so we will get on with accentuating the positive aspects and minimizing or eliminating the negative aspects. A variety of fibre preparations and spinning techniques have been used to resolve or minimize negative characteristics or may have been used to show why there is a problem.
Short Staple Fibres

Llamas in the mid-western and southern parts of the United States suffer greatly from heat stress with a combination of high humidity and high temperatures, so should be shorn as soon as the weather gets milder in the spring. A longer period of time would allow for more fibre growth. Older llamas, especially, tend to grow less fibre in this period of time. Some of the llama fibre could have very short staples, but consider other fibres with short staples to see how they perform when prepared and spun with different techniques. The samples using cotton, Cheviot, cashmere, and angora are used to support the ease of spinning shorter fibres with special selections of fibre preparation and a variety of techniques in spinning.

Please note that short leg wool and belly wool from llamas are not normally considered quality fibres and will not be included in this study. When approaching short fibres, it is necessary to consider many factors in making your preparation or spinning choices (see Appendix A, Illustration # 5):

- The structure of the fibre – straight or crimpy.
- The preparation options which work with short fibre – loose fluff, punis, rolags, roving, or spinning from the end of a carder.
- The amount of twist it will take to hold the fibres together in a fine or thicker yarn. Learn to use the wheel ratios to do the work and develop skill adjusting the tension to take the single onto the bobbin at the best rate to handle the sometimes very fragile singles.
Cotton:

Cotton has a very short staple – one to three inches - which requires high twist to hold the short, straight fibres together. Cotton often comes to the spinner in the form of combed top which I find more difficult to manage for general control in spinning than making punis of the fibre for a tidier spinning package (see Appendix A, Illustration #6). To make a puni, I use cotton hand carders and lash on small sections of the cotton roving across one carder in the direction from handle to the tip. I take the second hand carder to comb these fibres toward the tip of the first carder. After performing a couple of transfers, I use a small dowel rod (just a little longer than the width of the carder) to roll the carded fibre from the tip of the carder toward the handle. If this rod isn’t extremely smooth, the fibres will snag and be difficult if not impossible to remove. Following the procedure of fibre removal from the carder, the rod is rolled gently on a table or on the carder with the fibre around it to compact slightly before removing it. Once the puni is removed from the dowel rod, the result is a tidy fibre package that can be drafted from its end for spinning. Plenty of twist is required to hold the fibre together and to plan ahead for plying as it will lose some of that initial twist.

The spinning wheel is set up with a ratio of 12.25:1 by placing the drive band on the largest pulley of the fast flyer. The first sample is spun from a puni for control of the fibre while spinning in the woollen style. A small section of the cotton is attached to the leader before starting to spin. The forward hand is placed close to the orifice to pinch the leader and loose fibre to be attached. Treadling begins and the forward hand continues to control the twist to keep it building without moving into the unspun fibre. The twist is released into a small section of the puni as it is drawn backward. Since the fibres are not
as parallel in the fibre taken from the supply, the twist flows into it and requires drawing back more to smooth out unspun lumps and to establish a stable single. Once this elongating is complete, the whole section of spun single is allowed to draw onto the bobbin and the yarn is once again pinched off by the forward hand to add more twist for the next section to be spun.

On a humid day, cotton is a difficult fibre to handle as it sticks together and does not draft well. During the study, I encounter such a day causing clammy hands and a cotton puni that grabs and refuses to draft evenly. I consider this one of those learning moments and try a second sample using the same cotton carders. After carding the cotton I remove small sections at a time for spinning. This technique allows for a minimum of handling so the fibre remains loose for easy drafting. The short fibres and the lack of crimp call for putting plenty of twist into the spinning. I continue with my fast flyer and the previously used ratio of 12.25:1 for the necessary twist to keep the fibre from slipping apart as I spin this sample with the same woollen technique as described for the first sample. The only difference is having more fibre available at a time with the puni than when lifting the small swatches from the carders. Cotton is generally spun at a fine grist due to its heavy weight, so I can carefully control the amount of the fibre I am drafting to maintain this fineness. If greater grist is desired, more plies may be put together to make the heavier yarn. If there is not enough twist in the singles, the fibres will drift apart quickly during the plying process. Both samples are plied and skeined on a niddy noddy for wet finishing. This fibre presents three difficult aspects: short staple, lack of any crimp, and slippery nature. This fibre was handled successfully with fibre preparation and
spinning mechanics which a spinner also should be able to apply to make other short fibres much easier to handle (see Appendix B, Samples 1 & 2).

**Camel Down:**

Camel down is the soft undercoat from the camel with a one to three-inch staple and is slippery. The fibre is generally bought in bags of loose fluff. It is possible to spin directly from the bag of fluff if it has not compacted from storage. Otherwise, cotton carders or fine hand carders may be used to prepare punis, rolags, or fibre may be spun from the ends of the carders. Preparing a package delivers a more uniform drafting experience to control grist. For my sample, I spin from the ends of my cotton carders with the tension set just high enough to take the single onto the bobbin and use the pulley with a 12.25:1 ratio for optimum twist. The nice camel down fibre is spun woollen and results in a fine, soft yarn. It is often recommended that short fibres be spun with the woollen long draw to maintain the light, fluffy characteristic of the fibre. Twist is built ahead of the forward hand before allowing it to move into short sections of the fibre supply that have been drafted at basically the same time. The process allows the twist to grab those fine, slippery fibres to bind them together. Slippery fibres require a high spinning ratio to keep the fibres from drifting apart. The resulting sample is plied and wet set for finishing. Although the camel down is a little crimpier than the earlier cotton sample, the techniques I apply function well (see Appendix B, Sample #3).

**Cashmere:**

Cashmere has a short staple of 1 ¼ to 3 ½ inches, has a little crimp, is plenty slippery due to its fineness of 16 microns or less. How do we handle it? Cashmere is generally spun
very finely due to its cost and the warmth it generates; it is frequently used as a blending fibre to add luxury and softness to other fibres. These fine, slippery fibres require a high twist to make them hold together. The fibre generally arrives in a bag of fluff, but might be carded with hand carders into punis or small rolags or spun directly from the ends of the carders if it has compacted in storage. I choose to prepare the fibre from the ends of my cotton hand carders, not wanting to handle the delicate cashmere any more than necessary. The sample is spun with a ratio of 12.25:1 and just enough tension to take the fibre onto the bobbin without tugging. The fibre reacts well to this technique. Spinning cashmere in a worsted style to make a firm yarn would really defeat using the assets of this fine fibre, so I continue with the woollen style of spinning. I spin this sample by building twist between the orifice and my forward hand. Once the twist is sufficient, I allow it to move into a small amount of the fibre supply while simultaneously drafting backward. The twist is limited to the small section which is drafted and was elongated to smooth out any lumps for an even, stable yarn. As soon as this attenuation is complete, the whole length of the single is allowed to go onto the bobbin before repeating the process with the next section of fibre (see Appendix B, Sample #4).

**Angora:**

Angora is an inexpensive luxury fibre known for its halo and warmth. It generally is short stapled (1 ½ to 6 inches) depending on the supplier (Robson & Ekarius, 2011, p. 410), and may have guard hair which really is not much of a consideration. It is also straight and very slippery. The fibre can be spun from the fluff unless it has been stored and has become compacted. The spinning preparation could involve fluff, the puni or could be spun from the ends of the cotton carders as shown in previous samples. Since
angora felts easily, you would not want to roll the puni stick to compress the fibres or it would not draft properly. Angora also is affected by humidity and clammy hands.

Spinning angora requires a high twist to hold the straight, slippery fibres together for a stable yarn. I use my fine cotton carders to open up the fibres for spinning and to keep from over handling. A fine single is the result of spinning angora fibre with a ratio of 12.25:1 and a light tension on the bobbin. I use the woollen technique of building twist ahead of the forward hand and then allowing it to move into a section of the fibre supply which is drafting simultaneously before elongating and allowing the whole length to move onto the bobbin. A fine, soft, two-ply yarn is the result of plying these woollen singles. But, what happened to the halo? The halo reappears after handling the angora. Note that the warmth of this fibre makes it undesirable to use as a bulky yarn. Angora is often blended with other fibres to alleviate the felting problem or is blended with other fibres to add softness, warmth or that halo (see Appendix B, Sample #5).

**Down Fibre – Cheviot:**

Cheviot is not extremely short, but is one of the shorter woolled of the down breeds according to the Fournier and Fournier (1995) chart of down breeds of sheep. My wool sample has a staple of three inches. Cheviot is a soft, spongy fibre with a lot of crimp. The roving has been stored for some time and needs to be loosened for drafting purposes; I pull the roving gently from each side to loosen the fibres. Hand carders could be used on it, but I would suggest cotton carders or fine wool carders to prevent unnecessary neps or noils. I spin the first sample from the roving, but continue with the use of the 12.25:1 pulley in the spinning ratio. Clearly this is not a necessary step to keep the crimpy fibre together. It is also harder to control the grist from the roving because the fiber has been
compacted. A slower ratio would also benefit the control of the grist. You can see the uneven twist in the fibre as a result of both the high ratio and compaction (see Appendix B, Sample #6). I spin a second sample by preparing the fibre on cotton hand carders and spinning from the ends of the carders to provide a more airy, controlled drafting. The crimpy fibre does not require as high an amount of twist as the non crimpy cotton or the slippery, fine cashmere. I continued following the plan of spinning these short staples with a woollen technique. Twist is allowed to build between the forward hand and the orifice. I counted the number of treadles for consistency. As twist is released into a small section of the fibre supply, the unspun fibre is drafted backward and no twist is allowed into the main fibre supply. After this length of stable single is established, it is allowed to move onto the bobbin and the process is repeated. The second sample is much more even grist due to the way the fibre is prepared and handled (see Appendix B, Sample #7).

**Llama:**

The llama fibre from *Jellybean* is barely crimpy and fairly coarse in spite of being processed and de-haired commercially. Since the llama hair doesn’t get *neps* like some of the downy wools, I use woollen carders to put the fibre into a rolag for spinning. If the fibre does not seem to stay formed into a rolag, it can also be spun from the ends of the carders. The rolag is made by lashing fibre to the hand carders and then carding carefully and gently (see Appendix A, Illustration # 8). Once the fibres are in order, it is rolled from the tip of the carders toward the handle of the carder into a loose roll to be spun from the end of the package. (I use two dowel rods to capture the ends of these wispy fibres to roll into a rolag.) This resembles the puni, but is a much airier package. The
llama fibre can be spun from the commercial roving as it generally drafts well. 

*Jellybean’s* fibre is about three inches long, so can be spun woollen or worsted, depending on the desired yarn. I cut the staple in half for my second sample to show how it would react to the same technique of spinning and could still be spun. Both samples are carded and put into rolags before spinning woollen with the 12.25:1 ratio with low tension on the bobbin. This llama hair is not crimpy and fairly slippery, but even when I cut it into the 1½-inch staple length, it is not difficult to handle due to the preparation and spinning technique. The 1½- inch and the 3-inch samples are spun woollen by using the forward hand to control the build-up twist in the fibre before being released into a small undrafted section of the fibre supply. Both lengths of fibre perform well and are easily elongated to remove the unspun lumps before being allowed to travel to the bobbin.

Although the three-inch staple and the 1½- inch staples are both possible to spin, this is not a soft llama fibre. (see Appendix B, Samples #8 & #9).
"It Itches!"

Many fibres are uncomfortable because they are coarse and/or they may contain vegetable matter, dirt, guard hair, or second cuts. Others may have gone through a harsh cleaning process that damaged the fibres, or maybe the spinner just made the twist a bit too tight. All of the above reasons for coarseness may be present in llama fibre but there could be even more causes: the age of the animal, weathered fibres, high micron count, illness in the llama, or waste fibre (belly wool, leg wool, guard hair).

In this section of the prickly, itchy negative aspects of llama fibre, I have shown several samples of different fibre qualities. Other samples show the effects of spinning techniques with llama fibre — good and bad. Additional samples of llama fibre in this section are samples blended with silks, angora, and cashmere containing different percentages of the blending fibres to allow the reader to decide when the percentage of the blend is adequate for improvement. All these samples are created to address the negative aspect of scratchy fibres.

If llamas generally have fibres in the range of 16 to 40 microns, with 30 being the limit of next-to-the-skin desirability, we would choose to use fibres lower than 30 microns.

Seeking softness through spinning technique:

My llama Mapache is the first example of hairy, dirty, and coarse fibre from an old llama. Even though I love the animal, the fibre is clearly one to designate for a rug (see Appendix A, Illustration #7). Mapache’s fibre is washed and hand carded into rolags and spun with a light touch for a woollen yarn. The quality of the fibre made it very difficult to spin properly. The spinning technique is generally acceptable for a nice yarn,
but everything else is wrong. This is fibre you might encounter as a novice in your fibre search. It is unsuitable for next-to-skin wear and is used mainly for rugs or crafts. This sample is presented as a learning opportunity. Even the woollen spinning technique to make the most of loft and softness, is unable to make this yarn desirable (see Appendix B, Sample #10).

*Mambo* (llama) has some of the nicest, finest llama fibres I have ever spun. The fibre has been given to me by a friend and came in nice, firm rovings. This is totally opposite from *Mapache*. I spin *Mambo* woollen using a light twist build-up and slow treadling as the twist is released into a small section of the fibre supply. The singles are easy to handle to even out the soft spots before allowing the yarn onto the bobbin. This serves as the perfect contrast to the first sample in this section (see Appendix B, Sample #11).

*Godiva* (llama) is one of my earlier llamas. Her fibre has been sent to a mill for washing, sorting, dehairing, and carding into roving. In spite of this diligent preparation, a few guard hairs remain. By carding the fibre on my cotton carders, I easily remove many more of the guard hairs for a nicer hand. The carding process is followed by making rolags for spinning woollen. I allow a twist build-up into a section of undrafted fibre from the fibre supply, let the twist into this section, elongate and let the bobbin take the entire section. The singles spin easily and are plied into a nice two-ply yarn before being wet finished and skeined (see Appendix B, Sample #12).

A second sample from *Godiva* is spun with a very different technique to show the effect of the spinning technique on the fibre. I spin this directly from the commercial roving and intentionally over-spin it with a worsted technique. This actually results in a semi-
woollen yarn due to the woollen preparation. Spinning worsted involves *inch worming* the fibre forward draw, smoothing it tightly without allowing twist to move beyond the forward hand. The tight twist brings every guard hair to the surface and accents the harsh feel. Any new spinner can easily run into this problem while trying to manage treadling, drafting, and holding on too long before letting the single draw onto the bobbin (see Appendix B, Sample # 13).

*Taffeta/Fiesta* (llamas) are a blend because of their similarity in staple length and feel by the fibre mill which prepared them into roving. Although there is a small amount of guard hair remaining even after the commercial dehairing process, the processed fibre has a nice hand. I spin this sample woollen for another example of the feel of a yarn with some guard hair. By spinning the fibre without a tight twist with a woollen technique, the guard hairs are not brought to the surface. The yarn is not perfect, but does that eliminate it from being used? Maybe this yarn is suitable for a scarf, hat, or mittens (see Appendix B, Sample # 14).

*BF Starr* (llama) is fibre from a friend who raises llamas and always spends a lot of time preparing fibre before it is ever sent to a mill for processing. Note that even commercially prepared fibre can come back with vegetable matter making it scratchy, so this is an important consideration in purchasing fibre. The mills stress that the cleaner the fibre comes to them, the better the resulting processed fibre will be. *BF Starr*’s fibre arrives as a commercially prepared roving and has been dehaired. It drafts smoothly as I spin it with the woollen technique. Having the twist under control, it moves into the loose fibre supply and allows it to be loftier and light (see Appendix B, Sample # 15).
The second sample of *BF Starr* (llama) is spun with a worsted technique using a short forward draw. No twist is allowed into the fibre supply and the single is smoothed as it is released onto the bobbin. The combination of the woollen preparation and the worsted technique yields a semi-woollen yarn. Starting with a nice fibre and even changing the technique of spinning resulted in a nice yarn (see Appendix B, Sample #16).

**Blending for a finer hand to the yarn:**

Sometimes we remedy the *hand* or softness of a fibre by adding other fibres such as silk, angora, cashmere, etc. If a fibre is a little coarse (high micron count), this may be the perfect solution for marked improvement; on the other hand, if the fibre is very coarse (over 30 microns), the end product will not be desirable and much nice blending fibre will be wasted in the process. When blending, fibres should be weighed for accuracy and a duplicable blend. *Eyeballing* blends will not work because of the great weight differences in fibres (see Appendix A, Photo #9). For example, if the total weight of a sample is four grams, a blend of 50 percent is two grams of each fibre; 25 percent is one gram from one of the sources and three grams from the other; ten percent is .4 grams of one fibre and 3.96 grams of the other; five percent is .2 grams of one fibre and 3.98 grams of the 95 percent portion.

Furthermore, blending fibres of similar staple lengths makes it easier to achieve a homogenous blend, rather than trying to blend very long-stapled fibres with very short-stapled fibres. It is often desirable to cut fibres that are too long to blend with very short fibres to achieve a more homogenous blend. Fibres of different lengths tend to clump together in the drafting. Personally, I like to blend long fibres on hackles or combs for a
better blend with less waste. Medium to short fibres are not difficult to blend on hand carders.

*Flash* (llama) has nice fibre, and is commercially de-haired into roving with very little guard hair remaining. The first sample is spun directly from the roving, allowing the twist to travel along the attenuated yarn to the fibre supply in what would be called a semi-woollen technique. The resulting sample was not unpleasing, but the following samples show what two blends of tussah silk and two blends of Bombyx silk contribute to the end product (see Appendix B, Sample #17).

The next sample is the result of blending *Flash* (llama) and tussah silk. (75 percent llama/25 percent silk). The fibres are hand carded to blend carefully. The purpose is to see how much silk is necessary to change/improve the actual *hand* of the llama fibre. The fibre is spun from rolags after carding and uses the same semi-woollen spinning technique as the previous sample from *Flash*. The twist is allowed to travel into attenuated fibres toward the fibre supply. The blend does help the *hand*, but does not add the lustre as I had hoped it would (see Appendix B, Sample #18).

Following the first blend of *Flash* (llama) and tussah silk, I increased the tussah silk to 50 percent of the blend. I use the same semi-woollen technique by drafting the fibre backward and allowing the twist to travel along the attenuated fibre toward the fibre supply before winding onto the bobbin. The difference from adding the greater amount of silk could be felt but the lustre remained unchanged (see Appendix B, Sample #19). At this point, I changed the blend in the sample to *Flash* and Bombyx silk (75 percent llama/25 percent silk). The blend is achieved using a hackle and a diz is used to remove
the blended fibre from the hackle into a worsted preparation. I spin the blend semi-worsted, allowing the twist into the fibre as it is drafted backward with the fibre supply hand and then allowing the twisted fibre to go onto the bobbin. The silk contributes to the feel of the yarn and the Bombyx silk gives lustre as well (see Appendix B, Sample #20).

Is more silk necessary? The final blend of silk is *Flash* (50 percent) and Bombyx silk (50 percent). The semi-worsted spinning technique is used. The resulting two-ply yarn is pleasant, and the lustre is superior to earlier blends with tussah. Concerning the 50/50 blends of llama/tussah silk and llama/Bombyx silk, the question remains of the necessity of adding that much silk to make a desirable yarn (see Appendix B, Sample #21). The amount of the blending fibre would relate to the coarseness of the principal fibre.

*Hankee Pankee* (llama) has coarse hair and abundant guard hair even after commercial processing and dehairing. I card the roving on my hand carders to make rolags. As I build up twist with the forward hand, the rolag easily drafts backward as I allow the twist into sections of unspun fibre for a woollen technique. The resulting yarn is lofty but not totally soft, mostly due to the guard hair protruding from the yarn. I use this sample to see if it might be improved by adding angora (see Appendix B, Sample #22).

*Hankee Pankee* llama (90 per cent)/angora (10 percent) are blended on hand carders in small sections and the fibre feels really nice on the carders. The purpose of this blend is to see how a small amount of angora would result in change of the hand. The blended fibre is rolled into rolags for easy manipulating in the woollen spinning. The leader is connected to the loose fibre and pinched as treadling begins to build up enough twist to
join the fibre supply. Once joined, the forward hand pinches close to the orifice (three to four inches) so the twist can build up. Once the twist build-up is sufficient, it is allowed into a small section of the fibre supply while being drawn backward. A few lumps appear which are elongated backward until the single is stable and even. At that point, the twisted single is allowed to move onto the bobbin and the twist is once again blocked by the forward hand for build-up and to allow additional twist to flow into a section of the supply as it is drafted backward. Following plying the singles into a two-ply yarn, the fibre is wet finished. This yarn is spun a little finer than the unblended sample, but is still not as soft as I had hoped. If the llama sample had been finer, this blend might have been sufficient (see Appendix B, Sample #23).

Since the 10 percent blend of angora did not make much difference, I raise the percentage of angora to 20 percent to blend with 80 percent of Hankee Pankee (llama). The fibre is blended on hand carders after it has been weighed for precise percentages in the blend. With the 20 percent blend of the white angora to the 80 percent of the brown llama, the color is noticeably lighter. The spinning is performed with the same woollen technique. I build up twist, allow it into a small undrafted section of the fibre supply, elongate the single to remove soft spots and allow the single to wind onto the bobbin. After spinning two singles, the fibre is plied, wet finished and dried. The feel of this fibre blend is much smoother and can be used for a scarf, mittens, or hat. (see Appendix B, Sample #24).

I want to see if a higher blend would be a softer blend, so I skip to a 50 percent angora/50 percent Hankee Pankee (llama) blend. I have quite a pile of angora compared to the llama and it is not easy to blend with the hand carders for a homogenous blend. Small sections are blended and then those sections are re-blended and rolled into rolags. The
fibre is spun woollen. The soft lumps were easily attenuated for removal to make a stable, smooth yarn. Clearly, this blend lost nearly all of the llama characteristics and the colour was much lighter than any of the earlier blended samples. I feel this is overkill with this particular llama fibre and if any other llama fibre is so coarse that it requires this 50/50 blend, there would be a quick decision that it might not be worth it (see Appendix B, Sample #25).

*Taffeta* (llama) has a softer, finer feeling fibre than *Hankee Pankee’s*. It, too, has been commercially dehaired and prepared into roving. This fibre is short and the roving is very thin, unstable, and comes apart easily. I hand card sections from the roving to make rolags for a package that holds together better for the woollen technique which requires attenuation. The loose roving would have been a constant problem with the drafting process. The yarn from this sampling is just coarse enough to the hand that it probably would not be desirable for an item to be worn next to the skin (see Appendix B, Sample #26).

Taffeta (llama) fibre meets some very fine cashmere for the first blend. The lengths of the two fibres are very easily carded for blending with 5 percent cashmere/95 percent Taffeta (llama). The micron count of the cashmere is 16 microns or less, so definitely is not going to be large percentage of the blend. Cashmere is a luxury fibre and very warm; too high a blend could be a comfort factor as well as an expense factor to consider. This particular blend is selected because of some clothing I have with this blend of cashmere on the label. I carefully weigh the cashmere fluff and the thin llama roving for the blend and use hand carders for the blending process. The blended fibre is rolled into rolags for the woollen spinning technique. The build-up twist between the forward hand and the
orifice is allowed into a small section of the undrafted fibre supply while drafting backward. Once this section of the fibre supply is spun, elongated and stable, the single is allowed to wind onto the bobbin. Even such a small combination of the cashmere adds greatly to the overall hand of the llama (see Appendix B, Sample # 27).

Probably, the five percent blend could be a stopping point, but it is worth the small investment in cashmere to step up the percentage to see if it is necessary to make a significantly more desirable yarn. Hankee Pankee (llama) is blended at 90 percent to 10 percent cashmere for this final sample. Hand carders are used for blending before rolling the blended fibre into rolags. As I connect this fibre to the leader on the spinning wheel, I can already tell this will be a slippery combination and very soft. The singles are spun woollen and the drafting is very fluid as the fibres are drawn back to remove the soft bumps before winding onto the bobbin. After the fibre is plied and wet finished, it really is a nice yarn that someone might want to repeat for a total comfort factor for next-to-the-skin wear. Once again, I caution those who are planning to blend fibres to consider the quality of the fibre to be improved and plan accordingly. In Robert Donnelly’s words, “You can’t make a great yarn from lousy wool, but you can make lousy yarn from great wool” (Parkes, 2007, p. 64) (Appendix B, Sample #28).
Elasticity in Fibre

Have you owned a pair of socks with the tops stretched out and falling down? Do you have a favorite sweater that grows as you move through the day wearing it? These are instances when elasticity in fibres is certainly important to structure. On the other hand, inelasticity is also a characteristic that may give beautiful drape to cowls and shawls. Fibres such as wool have elasticity derived from its crimp giving it the ability to spring back into shape and hold shape better. Llama hair has very little crimp so will stretch and will not return to its original size without blocking. Llama certainly is not the only fibre without this elasticity - consider silk and cotton as just two of several other popularly used fibres. Some people try to use ribbing as they knit llama or try to crochet to combat the lack of resilience, but these are not totally satisfactory solutions. Blending seems to be the recommended remedy for when elasticity is desired.

Samples of Merino, Corriedale and llama are spun separately with the same technique and wet finished (see Appendix B, Samples #29, #30, #31). Each fibre is hand carded, put into rolags and spun woollen with the backward draw. The woollen technique is used to give the maximum amount of stretch in the samples. Worsted yarns do not tend to stretch as much. Equal lengths are stretched and relaxed to show the degree of elasticity in each. To be better to understand the changes in the yarn and its resilience, the changes are recorded on the chart and shown as percentages of change from the original sample.
**Blending for resilience:**

It is generally recommended to use at least 20 percent to 50 percent wool when blending for elasticity. Parkes (2007) suggests blending 50 percent wool to a less elastic fibre for added elasticity. For this study, I blend 75 percent llama with 25 percent sheep’s wool using Merino for one sample, and Corriedale for the second sample (see Appendix B, Samples #32 & #33). By using the same technique of finishing the fibre and stretching, then releasing, we can observe the degree of elasticity the wool has added to the llama. Variables in another person’s sampling could be results from that person’s spinning technique, the grist of the yarn, the crimp in the llama fibre, or the amount of crimp in the blending fibre. Will it be enough to satisfy the needs of your project or can you be happy with reserving llama fibre when you desire drape in your yarns?

The following chart shows the changes in the yarn (blended and unblended) - the basic relaxed yarn to a manually attenuated yarn, and finally a yarn released from the tension to see how it bounces back. The examples clearly show the blending gave the fibre resiliency for purposes of elasticity.
Basic Yarns Change Elastic Properties through Blending

<table>
<thead>
<tr>
<th>Sample</th>
<th>Relaxed Yarn</th>
<th>Attenuated Yarn</th>
<th>Resiliency</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Appendix B, Sample #29)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Merino</td>
<td>38.1 cm</td>
<td>45.7 cm, +7.6 cm, 20%</td>
<td>38.1, 100%</td>
</tr>
<tr>
<td>(Appendix B, Sample # 30)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corriedale</td>
<td>38.1 cm</td>
<td>45.7 cm, +7.6 cm, 20%</td>
<td>38.1, 100%</td>
</tr>
<tr>
<td>(Appendix B, Sample #31)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brocade (llama)</td>
<td>38.1 cm</td>
<td>40.64 cm, +2.54 cm, 7%</td>
<td>39.37, +1.27 cm, 97%</td>
</tr>
<tr>
<td>(Appendix B, Sample #32)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brocade (llama) 75%/ Merino 25%</td>
<td>38.1 cm</td>
<td>43.18 cm, +5.8 cm, 13%</td>
<td>38.1, 100%</td>
</tr>
<tr>
<td>(Appendix B, Sample #33)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brocade (llama) 75%/ Corriedale 25%</td>
<td>38.1 cm</td>
<td>40.64 cm, +2.51 cm, 7%</td>
<td>38.73, +1.3 cm, 99%</td>
</tr>
</tbody>
</table>
Slippery Fibres

Slippery fibres make spinning interesting, especially for new spinners. While the spinner is concentrating on treadling, drafting, and allowing the fibre to draw onto the bobbin, the added problem of slippery fibre can be very upsetting. This is frustrating, but is a normal occurrence with other slippery fibres: silk, bamboo, rayon, nylon, fake cashmere.

Spinning in the grease is a possible technique in spinning llama to alleviate some of the slipperiness, but llama hair is not really that greasy. Many people do not enjoy the feeling of handling dirty fibre, and the fibre we purchase in roving is already washed.

Some slippery fibres come in the form of combed top which can be unruly. This fibre has been combed leaving parallel fibres of approximately the same length in the top. Very fine llama/alpaca could fall into this category; suri llama is generally straight and fine like hair. How is the best way to handle these fibres?

Some suggestions for handling slippery combed top:

1. Card the fibres to change the package from the combed top to a rolag.

2. Fold the fibre in small batches over the index finger (spin over the fold).

3. Blend with other fibres with more crimp.

*Pearl* (llama) has *suri* fibre provided to me for this study by a good friend. This is my first encounter spinning *suri*. I spin one sample from the top in a worsted technique. Drafting and keeping the fibre supply hand moving backward to allow for this extra length takes some concentration, but it is possible (see Appendix B, Sample #34).
For the second sample of *Pearl*, I hand card the top and roll it into a rolag to spin woollen. Generally longer fibres are spun worsted, but I wish to give it a try. It works okay by very careful management of the fibre supply. The woollen preparation and spinning provide a bit loftier, softer yarn than the first sample (see Appendix B, Sample #35).

Another of my llamas (*Fudge*), is not suri, but has very fine, shorter fibre. I am able to spin this after carding and rolling onto a larger dowel rod for a rolag. This fibre is very slippery, but that also allows for beautiful drafting for spinning with an attenuated long draw – letting the twist build, then allowing it into the undrafted fibre supply and elongating to an even grist before allowing to feed onto the bobbin. The preparation allows for easier handling (see Appendix B, Sample #36).

I repeat the attenuated long draw technique I used with *Fudge* with *Kaleigh*, a llama with fine fiber. This is also is a very satisfactory experience with the long draw. The fineness adds to the slipperiness, but I have no difficulty in spinning this yarn (see Appendix B, Sample #37).

I try some fibre from another llama (*Brocade*) that is a *huacaya*, but fairly long-stapled and I spin this fibre from the commercial roving over-the-fold. Allowing enough twist to capture the slippery fibres in the woollen technique seems to be a key ingredient in spinning a nice two-ply yarn (see Appendix B, Sample #38).

In earlier samples I demonstrate blending of llama and wool (Corriedale or Merino) for elasticity. Blending with other fibres that are not as slippery or that have more crimp often gives good results for spinning slippery fibres (see Appendix B, Samples 32 & 33).
The final sample is *Pearl, a suri* llama, using 75 percent llama and 25 percent mohair. Both fibres are long and basically without crimp, although the mohair is coarser and seems to have a bit more *tooth*. The blend is made to see if the slippery llama could be controlled a bit better. Blending is performed on woollen hand carders and the fibre is rolled into a rolag. Following general recommendations for longer fibres (McCuin, 2009; Parkes, 2007), I spin the fibre semi-woollen – using the technique of allowing twist to travel into attenuated fibres toward the fibre supply, without letting them into the fibre supply. The fibre spins easily and with little slippage. This sample also benefits from the lustre of both fibre sources (see Appendix B, Sample #39).
CONCLUSION

Unlike Merino sheep with a development for a certain grade of fibre over hundreds of years, llama fibre appeared on the scene in the United States as a spinning fibre after it had gone through the business of being an exotic breeding animal, then a show animal. At the same time this fibre is developing into a hand spinning fibre, we have a multitude of spinners previously experienced with wool and a few other fibres. At the turn of the 21st century we see the numbers of new spinners increasing to create a demand for updated references and tutorials. The bibliography reflects many of these new references.

With these new spinners, new resources, and the growing use of the internet, a variety of fibres are now available. While this is a great opportunity for spinners, without proper research, a basic understanding of individual fibre characteristics, and experience in spinning, it also opens the door to misconceptions, negative attitudes, and wide assumptions about any given fibre. Many spinners have never been around any of the fibre sources (four-footed or otherwise). I can remember being amazed in my first Master Spinner’s Class, handling my first dirty fleece and seeing the miraculous change in it after being washed and prepared for spinning. If I had not experienced this, I would never have known such a positive change was possible.
RECOMMENDATION

Every spinner should resolve to continue learning how to spin different fibres with as many possible spinning techniques as may be offered. I think the multitude of fibre preparation techniques explored in this study demonstrate the possibilities for developing confidence in the spinning experience. Blending different fibres, not just the usual ones, extends the horizons for the hand spinners for some unusual and exceptional discoveries. Spinning should be about joy, exploration, and discovery. Take negatives characteristics and strive to turn them into positive characteristics whenever possible. Do not avoid fibres because of something someone has told you about them; learn from your own exploration.
BIBLIOGRAPHY


Olds College Master Spinner Handbook (Level 6) 2014


Appendix A – Photos

Illustration #1 - From cover of Medicine and Surgery of South American Camelids – Dr. Murray Fowler. (1998)

Illustration #2 - My first llama, George Brett, inspired me to learn to spin, in spite of a lot of negative advice.
Illustration #3 – Lendrum Spinning Wheel manufactured in Canada. Double treadle, Scotch tension. Shown with medium flyer/pulleys.

Illustration #4 - Lendrum Flyers – fast flyer for high speed spinning of fine fibers; middle flyer for general spinning; jumbo flyer for spinning bulky or art yarns or for plying (Bobbin holds a lot of yarn!)

Below chart shows the various pulley ratios available for each flyer.
Illustration # 5 - Cotton carder with short stapled fibres used for hand spinning. Left to right: camel down, cotton, cashmere, angora, cheviot, and llama.

Illustration # 6 - Cotton carders with cotton lashed on for carding before rolling around puni stick for making punis.
Illustration # 7 - Coarse llama fibre works great for rugs. The guard hair also contributes to a durable rug.

Illustration # 8 - Llama fibre rolled into rolag for spinning on woollen carders.
Cashmere & Llama Fibre both weighed at 2 grams. Because the cashmere is so much lighter weight, it is clear that a 50/50 blend would have overpowering bulk compared to the llama. For duplicable blends, fibres should be weighed and recorded.
Short Staple Fibres

Sample #1 - Cotton. 1 ½ “ staple
Hand carded. Spun from puni.

Sample #2 - Cotton. 1 ½ “ staple.
Spun from fibre taken directly from ends of carders.

Sample #3 - Camel Down. 2” staple.
Spun woollen from fibre taken directly from ends of carders.

Sample #4 - Cashmere. 2” staple.
Spun woollen from fibre taken directly from ends of carders.

Sample #5 - Angora. - 3” staple.
Spun woollen from fibre taken directly from ends of carders.

Sample #6 - Cheviot. 3” staple.
Uneven. Spun from compacted roving and high ratio pulley.

Sample #7 - Cheviot. 3” staple.
Spun woollen from fibre taken directly from ends of carders.
Short Staple Fibres, continued...


Sample #9 – Jellybean (llama). 1 ½” staple (cut) – Spun woollen from rolag. Knitted on size 4 needles.

It Itches!

Sample #10 – Mapache (llama).
Fibre not sorted nor prepared properly. Spun woollen from rolags. Woven on 2” Zoom Loom.

Sample #11 – Mambo (llama) -
Spun woollen from rolag. Knitted on size 4 needles.
It Itches continued...

Sample #12 - Godiva (llama). Some guard hair. Spun woollen from rolags. Woven on 2” Zoom Loom.

Sample #13 - Godiva (llama). Intentionally overspun to show coarsness. Knitted on size 2 needles.

Sample #14 - Taffeta (llama). Spun woollen from rolags. Woven on 2” Zoom Loom.

It Itches Continued...

Sample #16 – BF Star (llama). Spun semi-woollen from roving. Woven on 2” Zoom Loom.

Sample #17 – Flash (llama). Spun semi-woollen from roving. Knitted on size 4 needles.

Sample #18 – Flash (llama) 75%/tussah silk 25%. Blended on hand carders. Spun semi-woollen from rolags. Knitted on size 4 needles.

Sample #19 – Flash (llama) 50%/tussah silk 50%. Blended on hand carders. Spun semi-woollen from rolags. Knitted on size 4 needles.
It Itches Continued...

Sample #20 – Flash (llama)
75%/Bombyx silk 25%.
Blended with hackle and diz.
Spun semi-worsted. Knitted on size 4 needles.

Sample #21 – Flash (llama).
50%/Bombyx silk 25%.
Blended on hackle and diz.
Spun semi-worsted. Knitted on size 4 needles.

Sample #22 – Hankee Pankee (llama). Hand carded and spun woolen from rolags.
Woven on 2” Zoom Loom.

Sample #23 – Hankee Pankee (llama) 90%/angora 10%.
Blended on hand carders.
Spun woolen from rolags.
Woven on 2” Zoom Loom.
It Itches Samples Continued...

Sample #24 – Hankee Pankee  
(llama)80%/angora 20%.  
Blended on hand carders.  
Spun woollen from rolags.  
Knitted on size 4 needles.

Sample #25 – Hankee Pankee  
(llama) 50%/angora 50%.  
Blended on hand carders.  
Spun woollen from rolags.  
Knitted on size 2 needles.

Sample #26 – Taffeta (llama).  
Commercially de-haired.  
Hand carded. Spun woollen  
from rolags. Woven on 2”  
Zoom Loom.

Sample #27 – Taffeta (llama)  
95%/cashmere 5%. Blended  
on hand carders. Spun  
woollen from rolags. Woven  
on 2” Zoom Loom.
It Itches Continued…

Sample #28 – Taffeta
(llama) 90%/cashmere 10% -
Blended on hand carders. Rolag.

Elasticity

Sample # 29 – Merino. Hand
carded. Spun woollen from
rolags.

Sample #30 – Corriedale. Hand
carded. Spun woollen from
rolag.

Sample #31 – Brocade (llama). Hand
carded. Spun woollen from
rolag. Knitted on size 4
needles.
Elasticity continued...

Sample #32 – Brocade (llama 75%/Merino 25%. Blended on hand cards. Spun woollen from rolags. Knitted on size 4 needles.

Sample #33 – Brocade 75%/Corriedale 25%. Blended on hand carders. Spun woollen from rolags. Woven on 2" Zoom Loom.

Slippery Fibres

Sample #34 – Pearl (suri llama). Spun worsted from combed top. Knitted on Size 4 needles.

Slippery Continued...


Sample #37 – Kaleigh (llama) – Hand carded. Spun woollen from rolags. Woven on 2” Zoom Loom.

Sample #38 – Brocade (llama). Spun woollen over-the-fold. Knitted on size 2 needles.

Sample #39 – Pearl (suri llama) 75%/mohair 25%. Blended on hand cards. Spun semi-woollen. Woven on 2’ Zoom Loom.
Appendix C– Micron Testing/Histograms

**FIBER TESTING TERMINOLOGY**

**Normal Distribution**

The graph of a normal distribution, the normal curve, is a bell-shaped curve. Many biological phenomena including animal fiber diameter distributions for single-coated animals, result in data distributed in a close approximation to normal. Hence, statistics applicable to normally distributed populations (mean, standard deviation, and coefficient of variation) are used to define these fiber diameter distributions. The normal curve is symmetric about a vertical center line. This center line passes through the value (the high point of the bell) that is the mean, median and the mode of the distribution. A normal distribution is completely determined when its mean and standard deviation are known.

Approximately 68.0 percent of all measurements lie within one standard deviation of the mean and approximately 95.0 percent of all measurements lie within two standard deviations of the mean. More than 99.5 percent of all measurements will lie within three standard deviations of the mean.

**Fiber Diameter Measurement and Distribution**

Fiber diameter is measured in microns. One micron is equal to 1/1,000,000th of a meter or 1/25.40017 of one inch. Mean Fiber Diameter (MFD) is in common use internationally. MFD, Standard Deviation (SD) and Coefficient of Variation (CV) all relate to the (approximate) normal distribution of the animal fiber diameters. SD characterizes dispersion of individual measurements around the mean.

In a normal population, 68% of the individual values lie within one SD of the mean, 95% within two SD’s and more than 99.5% within three SD’s. Since SD tends to increase with increasing MFD, some people prefer to use CV (SD/MFD) as a method of comparing variability about different stated means.

**Comfort Factor**

Comfort factor is the percentage of fibers over 30 microns subtracted from 100 percent. Ten percent of fibers over 30 microns corresponds to a comfort factor of 90 percent.

**Curvature**

Fiber curvature is related to crimp. Average Fiber Curvature (AFC) is determined by the measurement of two millimeter (2mm) slippets in degrees per millimeter (deg/mm). The greater the number of degrees per millimeter, the finer the crimp. For wool, low curvature is described as less than 50 deg/mm, medium curvature as range of 60-90 deg/mm, and high curvature as greater than 100 deg/mm.

Typical values might be illustrated by a 30 micron Crossbred wool fleece with typically low curvature and broader crimp with a frequency of approximately two crimps/cm. In contrast, a 21 micron Merino fleece typically has a medium curvature and a medium crimp with a frequency of approximately four (4) crimps/cm. A 16 micron Superfine Merino fleece typically has a high curvature and a fine crimp with a frequency of approximately seven (7) crimps/cm.

**Definition of Medullation**

A medullated fiber is an animal fiber that in its original state includes a medulla. A medulla in mammalian hair fibers is the more or less continuous cellular marrow inside the cortical layer in most medium and coarse alpaca fibers. By definition (ASTM), a kemp fiber is a medullated fiber in which the diameter of the medulla is 65% or more of the diameter of the fiber.
Appendix E, Micron Testing/Histograms, page 2

Medullation Measurement

Medullation measurement can be performed using either a projector microscope or the OFDA 100. Using IVTOMotor nomenclature, a kemp fiber is classified as an "object ondaie fiber" when measured on the OFDA 100. The OFDA100 measures opacity and therefore only white or light colored fibers can be measured. A reasonable assumption is that colored fibers have similar levels of medullated fibers as their white and pastel counterparts.

Spinning Fineness

This number (expressed in microns) provides an estimate of the performance of the sample when it is spun into yarn by combining the measured mean fiber diameter (NFD) and the measured coefficient of variation (CV). The original theory comes from Martindale but the formula used comes from Butler and Dilling and normalizes the equation so that the spinning fineness is the same as the MFD when the CV is 24%.

Length & Strength

Length is measured in millimeters (mm) and the reported measurements readjusted to an annual growth period. Strength is measured in Newtons/kilotex (N/ktx) and is the force (measured in Newtons) required to break a staple of a given thickness (measured in kilotex). On the earth's surface, one kilogram exerts a force of 9.8 Newtons (1 kg * acceleration due to gravity measured in meters/second²). Kilotex indicates thickness in terms of mass per unit length expressed as kg/km.

Intrinsic ally, alpaca fibers appear to be very strong, an average of 50 N/ktx or better is not unusual. From a processing point of view, a mean staple strength greater than 30 N/ktx is considered adequate for processing wool on today's high-speed equipment.

Resistance to Compression

The resistance to compression (RTC) of alpaca fibers is measured in kilopascals (Kpa). A pascal (Pa) is a unit of pressure equivalent to the force of one Newton per square meter. In the commercial sector, RTC values >11 Kpa are considered high, 8 to 11 Kpa medium, and <8 Kpa is low. The intrinsic resistance to compression of alpaca is low because of the relatively low levels of crimp. Thus, alpaca is not suited to end-uses that require high resistance to compression (or high bulk).

Position of Break

Truly sound fibers break in the middle section of the staple. Intrinsic ally, alpaca fibers appear to be very strong, in the 50 N/ktx range. A mean staple strength greater than 30 N/ktx is considered adequate for processing wool on today's high-speed equipment.

Clean Yield

Yield is based on bone-dry, extractives-free wool (alpaca) fiber or wool (alpaca) base (WB). Many different "commercial" yields are used in the international marketing of wool fibers. These are values calculated to predict the amount of clean fiber obtained after commercial scouring and/or after combing. Allowances are typically made for grease, ash, vegetable matter, and moisture. Various percentages of moisture are added in these calculations of commercial yield, which in some cases (very clean wool or some alpaca yields) may result in the clean yield exceeding 100%.

Yarn & MCColl Testing Laboratories, Inc., 540 West El Paseo, Denver, CO 80224-1023 USA
Tel: 303/294-0382 Fax: 303/795-6944 E-mail: ymccoll@ymccoll.com Web: http://www.ymccoll.com

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### Appendix E, Micron Testing/Histograms, Page 3

#### Yocom-McColl Testing Laboratories, Inc.
540 West Elk Place, Denver, Colorado 80216-1823 USA
PHONE (303) 294-0582 FAX (303) 295-5944
EMAIL: ymccoll@ymccoll.com

---

### Animal and Sample Description

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Breed: Lama Himalaya</td>
<td>Sample Location: fleece</td>
</tr>
<tr>
<td>Sex: Female</td>
<td>Sample Date: 10/04/00</td>
</tr>
<tr>
<td>Color: Red</td>
<td>Age: 10/04/00</td>
</tr>
</tbody>
</table>

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### Laboratory Data

- Mean Fiber Diameter: 27.3 microns
- Standard Deviation: 13.6 microns
- Coefficient of Variation: 39.3 %
- Fibers Greater Than 30 microns: 12.1 %

---

**Graph:** Fiber Diameter - microns

The Test Performed According to I.W.T.O Method 12
Appendix E, Micron Testing/Histograms, page 4

Yocom-McColl Testing Laboratories, Inc.
540 West Elk Place • Denver, Colorado 80216-1823 USA
PHONE (303) 294-0583 • FAX (303) 295-6944
EMAIL: ymccoll@ymccolll.com

Sirolan Louraman
Micron Test Report

Zelma Farm/Zelma Covaland
P.O. Box 946
Chisago City MN 55013 USA

Animal and Sample Description

Test No: 8·8372

Animal ID: 206774
Sample Location: Plucks
Sample Date: XXXXX
Age: XXX

Laboratory Data

Mean Fiber Diameter: 26.6 microns
Standard Deviation: 18.5 microns
Coefficient of Variation: 53.7%
Fibers Greater Than 30 microns: 31.2%

This Test Performed According to J.W.T.O Method 12
Appendix E, Micron Testing/Histograms, page 5

Yocom-McColl Testing Laboratories, Inc.
540 West Elk Place • Denver, Colorado 80216-1823 USA
PHONE (303) 294-0582 • FAX (303) 295-6944
EMAIL: ymccoll@ymccoll.com

Animal Name: Hungarian Pannon (20th)
Breed: Umma Hapagyu
Sex: Gelding
Color: Brown

Laboratory Data
Mean Fiber Diameter: 34.3 microns
Standard Deviation: 11.6 microns
Coefficient of Variation: 33.5 %
Fibers Greater Than 30 microns: 62.5 %

This Test Performed According to I.W.T.O. Method 12
Optical Fiber Diameter Analysis (OFDA100)
Micron Test Report

Animal and Sample Description

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<thead>
<tr>
<th>Animal Name: XXXXX</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Breed: Alpaca (Huacaya)</td>
<td>Sample Location: Side</td>
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<tr>
<td>Sex: XXXXX</td>
<td>Sample Date: XXXXX/XX</td>
</tr>
<tr>
<td>Color: XXXXX</td>
<td>Age: XXXXX/XX</td>
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</tbody>
</table>

Laboratory Data

<table>
<thead>
<tr>
<th>Mean Fiber Diameter: 27.8 microns</th>
<th>Spin Fineness: 36.6 microns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Deviation: 6.1 microns</td>
<td>Mean Curvature (deg/mm): 35.5</td>
</tr>
<tr>
<td>Coefficient of Variation: 22.4%</td>
<td>SD Curvature (deg/mm): 2° 1</td>
</tr>
<tr>
<td>Fibers Greater Than 30 microns: 23.5%</td>
<td>Comfort Factor: 76.6%</td>
</tr>
</tbody>
</table>

Fiber Diameter - microns

This Test Performed According to I.W.T.O Method 47
Appendix E, Micron Testing/Histograms, page 7

Yocom-Mccoll Testing Laboratories, Inc.
540 West Elk Place • Denver, Colorado 80216-1823 USA
PHONE (303) 294-0582 • FAX (303) 295-6944
EMAIL: ymccoll@ymccoll.com

Optical Fiber Diameter Analyzer (OFDA100)
Micron Test Report

Computer Bank Data
This is Final Report
Denver CO 80216 • 823 USA

Test No: 015001

Animal and Sample Description

Animal Name: XXXXX
Breed: Alpaca(Suri)
Sex: XXXXX
Color: XXXXX

Laboratory Data

Animal ID: XXXXX
Sample Location: Sdc
Sample Date: XXXXXX
Age: XXXXXX

Mean Fiber Diameter: 22.9 microns
Standard Deviation: 6.5 microns
Coefficient of Variation: 26.6%
Fibers Greater Than 30 microns: 0.6%

Spin Fineness: 23.5 microns
Mean Curvature (deg/mm): 2.0
SD Curvature (deg/mm): 12.5
Comfort Factor: 90.4%

This Test Performed According to I.W.T.O Method 47
Appendix E, Micron Testing/Histograms, page 8

Yocom-McColl Testing Laboratories, Inc.
540 West Elk Place • Denver, Colorado 80216-1823 USA
PHONE (303) 294-0582 • FAX (303) 295-6944
EMAIL: ymccoll@ymccoll.com

Optical Fiber Diameter Analysis (OFDA100)
Micron Test Report

Animal Name: XXXXX
Breed: Cashmere (Cut off at 304)
Sex: XXXXX
Color: XXXXX

Laboratory Data
Mean Fiber Diameter: 13 / microns
Standard Deviation: 3.4 / microns
Coefficient of Variation: 26.6 %
Fibers Greater Than 30 microns: 9.9 %

This Test Performed According to I.W.T.O Method 47
Animal Name: XXXXX
Breed: Colored Angora Goat
Sex: XXXXX
Color: XXXXX

Animal ID: XXXXX
Sample Location: Sdc (L)
Sample Data: XXXXXX
Age: XXXXXX

Mean Fiber Diameter: 28.7 microns
Standard Deviation: 8.1 microns
Coefficient of Variation: 27.2%
Fibers Greater Than 30 microns: 51.0%

This Test Performed According to I.W.T.O Method 12
Appendix E, Micron Testing/Histograms, page 10

Yocom-McColl Testing Laboratories, Inc.
540 West Elk Place • Denver, Colorado 80216-1823 USA
PHONE (303) 294-0582 • FAX (303) 295-6944
EMAIL: ymccoll@ymccoll.com

Optical Fiber Diameter Analyzer (OFDA100) Micron Test Report

Test No: 018650

Animal and Sample Description

Animal Name: XXXXX
Breed: Merino
Sex: XXXXX
Color: XXXXX

Animal ID: XXXXX
Sample Location: XXXX
Sample Date: XXXXXX
Age: XXXXXX

Laboratory Data

Mean Fiber Diameter: 12.2 microns
Standard Deviation: 4.0 microns
Coefficient of Variation: 30.0%
Fibers Greater Than 30 microns: 0.1%
Spin Fineness: 14.6 microns
Mean Curvature (deg/mm): 12.4°
SD Curvature (deg/mm): 67.1°
Comfort Factor: 99.6%

This Test Performed According to I.W.T.O Method 47
<table>
<thead>
<tr>
<th>#</th>
<th>Fibre</th>
<th>Preparation</th>
<th>Spinning Technique</th>
<th>End Use</th>
<th>Twist</th>
<th>Pliess</th>
<th>Yards</th>
<th>Grams</th>
<th>Twist angle</th>
<th>TPI</th>
<th>WPI</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>Cotton</td>
<td>Hand carded; punis</td>
<td>Woolen</td>
<td>Summer shawl</td>
<td>zzS</td>
<td>2</td>
<td>10</td>
<td>2.7</td>
<td>17'</td>
<td>10</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>#2</td>
<td>Cotton</td>
<td>Hand carded; pulled from tips of carders</td>
<td>Woolen</td>
<td>Summer top</td>
<td>zzS</td>
<td>2</td>
<td>10</td>
<td>1.3</td>
<td>24'</td>
<td>5.5</td>
<td>18</td>
<td>8</td>
</tr>
<tr>
<td>#3</td>
<td>Camel down</td>
<td>Hand carded on cotton carders; pulled from tips of carders</td>
<td>Woolen</td>
<td>Shawl</td>
<td>zzS</td>
<td>2</td>
<td>10</td>
<td>1.5</td>
<td>19'</td>
<td>5.5</td>
<td>23</td>
<td>20</td>
</tr>
<tr>
<td>#4</td>
<td>Cashmere</td>
<td>Hand carded on cotton carders; pulled from tips of carders</td>
<td>Woolen; attenuated long draw</td>
<td>Elegant shawl</td>
<td>zzS</td>
<td>2</td>
<td>10</td>
<td>1.2</td>
<td>20'</td>
<td>7.5</td>
<td>32</td>
<td>25</td>
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<tr>
<td>#5</td>
<td>Angora</td>
<td>Hand carded on cotton carders; pulled from tips of carders</td>
<td>Woolen</td>
<td>Lacy shawl</td>
<td>zzS</td>
<td>2</td>
<td>10</td>
<td>.8</td>
<td>20'</td>
<td>4</td>
<td>23</td>
<td>38</td>
</tr>
<tr>
<td>#6</td>
<td>Cheviot</td>
<td>Commercial roving</td>
<td>Semi-woollen; attenuated back draw</td>
<td>Sweater</td>
<td>zzS</td>
<td>2</td>
<td>10</td>
<td>2.7</td>
<td>27'</td>
<td>10</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>#7</td>
<td>Cheviot</td>
<td>Hand carded on cotton carders; pulled from tips of carders</td>
<td>Woolen</td>
<td>Sweater</td>
<td>zzS</td>
<td>2</td>
<td>10</td>
<td>1</td>
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<td>#8</td>
<td>Jellybean (llama)</td>
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<td>3&quot; staple; Hand carded; rolags</td>
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<td>Spinning Technique: Woollen</td>
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<td>End Use: Mittens; gloves</td>
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<td>#9</td>
<td>Jellybean (llama)</td>
<td></td>
<td></td>
<td>Cut staple 1 1/2&quot;; Hand carded</td>
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<td>Spinning Technique: Woollen</td>
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<td>End Use: Mittens; scarf</td>
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<tr>
<td>#10</td>
<td>Mapache (llama) Intentionally coarse sample to show poor fibre</td>
<td></td>
<td></td>
<td>Hand carded; rolags</td>
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<td>Spinning Technique: Woollen</td>
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<td>End Use: Horseblanket</td>
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</tr>
<tr>
<td>#11</td>
<td>Mambo (llama)</td>
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<td>Commercial roving</td>
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<td>Spinning Technique: Woollen</td>
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<td>End Use: Sweater</td>
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<tr>
<td>#12</td>
<td>Godiva (llama)</td>
<td></td>
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<td>Hand carded; rolags</td>
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<td>End Use: Vest</td>
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<td>#13</td>
<td>Godiva (llama)</td>
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<td>Commercial roving</td>
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<td></td>
<td>Spinning Technique: Worsted; overtwisted</td>
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<td></td>
<td></td>
<td>End Use: Craft yarn</td>
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</tr>
</tbody>
</table>
#14 Fibre: Taffeta/ Fiesta (llamas)
Preparation: Commercial roving
Spinning Technique: Woollen
End Use: Scarf, hat, mittens

#15 Fibre: BF Starr (llama)
Preparation: Commercial roving
Spinning Technique: Woolen
End Use: Sweater

#16 Fibre: BF Starr (llama)
Preparation: Commercial roving
Spinning Technique: Semi-woollen; short forward draw
End Use: Mittens

#17 Fibre: Flash (llama)
Preparation: Commercial roving
Spinning Technique: Semi-woollen
End Use: Outer garment, vest

#18 Fibre: Flash (llama) 75%/tussah silk 25%
Preparation: Blended on hand carders; rolags
Spinning Technique: Semi-woollen; attenuated backward draw
End Use: Shawl

#19 Fibre: Flash (llama) 50%/tussah silk 50%
Preparation: Blended on hand carders; rolag
Spinning Technique: Semi-woollen; attenuated backward draw
End Use: Sweater

#20 Fibre: Flash (llama) 75%/Bombyx silk 25%
Preparation: Blended with hackle; diz
Spinning Technique: Semi-worsted (spun woolen with worsted preparation)
End Use: Shawl
<table>
<thead>
<tr>
<th>#</th>
<th>Fibre</th>
<th>Twist</th>
<th>Twist angle</th>
<th>Plies</th>
<th>Yards</th>
<th>WPI</th>
<th>Grams</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td><em>Flash</em> (llama) 50%/ Bombyx silk 50%</td>
<td>zzS</td>
<td>16'</td>
<td>2</td>
<td>10</td>
<td>16</td>
<td>2.5</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Preparation: Blended on hackles; dizzed off</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Spinning Technique: Semi-worsted</td>
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<tr>
<td></td>
<td>End Use: Sweater</td>
<td></td>
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</tr>
<tr>
<td>22</td>
<td><em>Hankee Pankee</em> (llama)</td>
<td>zzS</td>
<td>17'</td>
<td>2</td>
<td>10</td>
<td>9</td>
<td>4.5</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Preparation: Comercially de-haired fiber; handcarded; rolag</td>
<td></td>
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<tr>
<td></td>
<td>Spinning Technique: Woollen</td>
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<td>End Use: Weft for woven shawl</td>
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<td>End Use: Bulky sweater</td>
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