Understanding Histograms and the Environmental Factors that Affect Them

By Eric Hoffman

Histo comes from the Greek word for loom or web, and gram means anything written or drawn. In the wool industry the word histogram has come to mean the permanent record of the quality of an animal's fiber production, as represented by samples of fiber and the statistical information derived from them.

Today's histogram is produced by a sophisticated machine that analyzes a fiber sample and produces a graph illustrating key measurements. A typical histogram, incorporating the scanning of thousands of individual fibers, contains information about average micron (AFD) as well as variability represented in three measurements: standard deviation (SD), the coefficient of variation (CV), and percentage of the sample that is over 30 microns (prickle factor). Special order histograms can now be expanded to include the percentage and distribution of medullation (hollow fibers) and curvature - in a fiber sample taken from a white or light colored alpaca - measured in degrees per millimeter.

The LaserScan histogram is very much a part of the evolving alpaca business in North America. Much of the foundation stock imported to North America from abroad was accepted or rejected for registration based on histogram results. Importers learned that finding animals that could pass screening based on a minimum adult weight of 105 pounds, with an acceptable histogram, could be quite challenging. In general, only animals between 18 and 30 months of age qualified. It was discovered that after 30 months many animals had coarsened to such an extent that they could no longer qualify (See Fig. 1, below).

Histogram results are often seen prominently displayed on animal's pens at shows or sale venues. At such events the histogram is transformed from an internal document that assists breeders in the phenotype assessment of an animal to an advertisement that attests to the alpaca or llama's fiber quality. The assumption is that the displayed histogram actually represents the animal in the pen. I would wager that most breeders listen to their conscience and accurately identify samples submitted for testing. However, since histograms have become an advertising statement, it is important to note that the testing laboratory must rely on the information provided by the sender to match the fiber sample to a particular animal.

FIG. 1

Fibre Characteristics Evaluation Form

Huacaya Fibre Characteristics	Deductions	SCORE =	
Micron Count (maximum 26 micron)			
Per micron (or fraction thereof) > 26 micron	-10	maximum score	+15
Standard Deviation (SD)			
Micron			
17 or less — max SD = 3.5			
17.1 - 19 — max SD = 4.0			
19.1 - 21 — max SD = 4.5			
21.1 - 23 — max SD = 5.0			
23.1 or more — max SD = 5.5			
Per 0.5 micron (or fraction thereof) > maximum	-5	maximum score	+15
Percent Fibre > 30 microns			
For each percentage point > 5% of fleece	-5	maximum score	+15

Suri Fibre Characteristics	Deductions	SCORE =	
Micron Count (maximum 27 micron)			
Per micron (or fraction thereof) > 27 micron	-10	maximum score	+15
Standard Deviation (SD)			
Micron			
17 or less — max SD = 4.0			
17.1 - 19 — max SD = 4.5			
19.1 - 21 — max SD = 5.0			
21.1 - 23 — max SD = 5.5			
23.1 or more — max SD = 6.0			
Per 0.5 micron (or fraction thereof) > maximum	-5	maximum score	+15
Percent Fibre > 30 microns			
For each percentage point > 5% of fleece	-5	maximum score	+15

TOTAL POINTS:....................(Max 45)

Signed---

Adding to a breeder's possible confusion is that there are different types of measuring technologies available. The Sirolan LaserScan, OFDA100 and the OFDA 2000 are probably the most familiar to camelid owners. These different tools have different strengths. It is important to know what each method is most apt to accurately measure.

The Sirolan LaserScan and OFDA100 are approved by the International Wool Testing Organisation (IWTO) and the

American Society for Testing Materials (ASTM). These tests are all performed under standard conditions for testing textiles (65% relative humidity at 70 degrees Fahrenheit). The OFDA2000 instrument, on the other hand, is not approved by these organizations. The Sirolan Laserscan and OFDA measure thousands of fibers when making a determination on average microns, standard deviation and coefficient of variation, while the OFDA2000 measure less than 100 fibers. The OFDA2000 does, however, measure diameter changes along the staple and does a good job of showing the effects of environmental factors. (For more information refer to Eric Hoffman's article, "Thoughts about Evaluating Alpaca Fiber," in the September 2003 issue of CQ).

For anyone interested in assessing fiber quality, it makes good sense to develop tactile discernment skills. While many North American breeders embrace the security and certainty that histogram results appear to offer, in South America (even among those with the means to use histograms) processors continue to rely upon the highly refined tactile skills of women sorters. Derek Michell, the CEO of the long established Michell & CIA alpaca fiber processing mill in Arequipa, Peru, says, "The alpaca processing business relies on the fingers of the women who sort our fiber. Their skill in classing fiber is very important to us." Summing up his thoughts on fiber fineness Derek Michell added, "At the end of the day how it feels is the most important."

Still, the technology of image analysis affords an objective insight into fiber assessment that was not available until relatively recently. There is no question that histogram reports produced by a Sirolan LaserScan and the OFDA100 are valuable tools for the experienced breeder and novice alike, providing the sample is taken and packaged properly. The sample should be at least a two-inch square taken from the midside of the animal as near to the skin as possible, and at least 1.5 inches in staple length. The sample needs to be placed into a quart-sized zip lock baggie with the staple intact and the cut end of the staple positioned at the top.

Balling the sample up and squeezing it into a small baggie makes it difficult to straighten out for sampling. The inherent quality of alpaca fibers having a low resistance to compression works against handling such fiber samples.

North American alpaca breeders (possibly some llama breeders as well) are often asked, "What is a good micron count?" When I ran a histogram on a sample taken from a vicuña (the wild progenitor of the alpaca), its incredibly fine fleece was measured at an average 12.7 microns, with a standard deviation of 4.2 and one percent of its fleece in excess of 30 microns. This vicuña had a high CV of around 33% because it is a double coated animal. The staple length is about one inch (2.54 cm). An impressive alpaca histogram may have an average micron of 20 or below with standard deviation of around 3 and coefficient of variation of below 20, with 1 to 3 percent of the sample exceeding 30 microns. Llama breeders may be surprised to learn that most guanacos (the wild progenitor to the llama) have an amazingly consistent undercoat of between 14 and 19 microns. Both llamas and alpacas have wider ranges in fiber diameter than their wild brethren. However, the domestic species yield a much higher fleece weight on an annual basis than their wild progenitors. The "histogram" is an individual animal fiber diameter and distribution "micron test report." Fleece weight would have to be a one time, annual weight at shearing to be a valid reporting figure for production records. The "Ideal Alpaca Community" test format includes staple length, but only fiber diameter/distribution and medullation are represented by a histogram.

Taking Environmental Factors into Account

It doesn't take long for a novice breeder to learn the histogram sales pitch: the lower the micron count, the lower the standard deviation; the fewer the microns over 30, the better the fleece. If an animal's micron average is low, the seller may make a quantum leap to claim that the entire animal is superior. It is important to realize that as long as the fiber is still attached to an animal it is not a static medium. For example, if a 12-year-old male alpaca whose micron count has crept up to an average of 27, but with a standard deviation of 4 and coefficient of variation of 16, is producing 8 pounds of fleece annually he is doing just fine. Compared to most 18-month-old animals the 12-year-old would appear coarse, but compared to other animals his age his histogram would be superior to most of them. When evaluating a histogram one must always try to take into account the many environmental factors (diet, age, pregnancy, stress, and so forth) that affect a fleece (and the histogram) as the animal matures.

Angus McColl, owner and director of Yocom-McColl Testing Laboratories Inc., in Denver, Colorado is quick to explain that while the histograms his laboratory produces are valuable information for the camelid breeder, each histogram needs to be considered in its own special context. "Histograms should be compared to other animals in the same herd of the same age, not against an animal living on a different diet and from an entirely different age group." Yocom-McColl requests the birth date of the animal, the date the sample was taken, the fiber color, breed type (huacaya or suri) and registration number, all of which become information included on the histogram report. Identifying the animal in question and recording its age and sampling date allows a knowledgeable person scrutinizing a histogram to get a sense of how a particular animal stacks up against others in the same age bracket, color and breed type.

Only a few researchers have recorded how alpaca fiber changes under various environmental conditions. George Davis, MAgrSc, Dsc. of AgResearch in New Zealand reported at the Australian Alpaca Association's International Industry Seminar in 1994 that the fiber of a group of alpacas grazing on nutritious year-round pasture increased on average about 3 microns a year, and individual animals had increases exceeding 9 microns. Davis's study included more than 100 adult animals that had been living in New Zealand for more than a year.

In 1997 while I was working as a screener for the Alpaca Registry Inc., I was able to set up a test group of 21 alpacas (ten huacayas and eleven suris), on two occasions four months apart, during a period of radical dietary change. Although this is a small sample of animals, the results indicate that for most animals simply changing the diet can easily alter fiber data results.

In the test group, the first fiber samples were collected shortly after the alpacas had been transported from the altiplano at the end of the dry season, when natural pastures are nutritionally depleted. All animals were sampled at the midpoint along the flank. The sample was taken as close to the skin as possible and care was taken to keep the sample intact with the cut end facing to the top of the collection baggie to assure the correct end of the sample would be tested. The animals in the study had arrived at the quarantine station in relatively good body condition, with most scoring 2 or 3 on a 5-point scale (See Fig. 2, below). Most of the animals were tuis (14 to 18 months old), in full fleece and had not yet finished growing. By definition, tuis produce the best quality fleece each animal will ever produce because it is the animal's first fleece.

This group of tuis was shorn immediately following fiber sampling. To maximize their growth potential, the animals were introduced to high-protein legumes (alfalfa, above) and a carefully regulated grain/pellet supplement. Four months later fiber samples were collected from the same twenty-one animals at the original collection sites where the fleece had regenerated. In the 4-month period between the original sample and the second sample the animals had gained between 10 and 20 pounds (4.5 and 9 kg) and appeared to be robust and in excellent health.

Though they had experienced rapid weight gain, none of the alpacas appeared obese. All received a body score of 3 (optimum) or 4 on a scale of 1-to-5. Some had grown an inch (2.54 cm) at the withers. The weight gains in a short time period were no less remarkable than the changes in their histogram results during the same period. As a group they experienced an average increase of 3 microns in diameter, moving the average of 21.8 to 24.8 microns, with individual animals skyrocketing 9 microns in four months. The average percentage of fibers greater than 30 microns in the sample group increased by a whopping 9.3 percent, from 6.7 percent to 16 percent - this was a result of the overall increase in average fiber diameter in the group.

On the other hand, standard deviation (SD) and coefficient of variation (CV) proved to be more stable measurements under these changing conditions. On average, standard deviation shifted upward by only one micron, the SD being a plus or minus figure from the mean. The coefficient of variation was practically as stable, showing a mild upward movement. Both measurements assess uniformity (consistency), which is directly related to hair follicle development on the skin, a characteristic primarily influenced by inheritance. Thus, these two measurements are usually less influenced by environmentally stimulated changes than the average fiber diameter (micron count).

Most histogram test results taken by breeders during the years of screening were very similar to the results of the pretests conducted by importers. Both the registries and importers used the same laboratory, which used the same laser scanning machines. However, the similarities between the two separate tests on the same animal can have a relatively short shelf life. The longer the intervals between tests the more likely dietary influences have had an impact, and the fiber is no longer what it was. In one

FIG. 2

Table 10.12 Coarsening due to the difference between a low- and high-protein diet.

Alpaca ID #	Avg. Fiber Diam.	Incr.	Actl. Micr. Incr.	SD	SD After 4 mo.	SD Incr.	% Over 30	Incr. After 4 mo.	Incr.	CV%	CV% After 4 mo.
1	20.8	25.9	5.1	5.0	5.8	0.8	5.0	20.7	15.7	24.0	22.4
2	24.4	27.2	2.8	5.4	6.6	1.2	13.0	28.8	15.8	22.1	24.3
3	21.8	22.8	1.0	4.9	5.5	0.6	6.3	9.4	3.1	22.5	24.1
4	18.1	21.3	3.2	4.5	5.6	1.1	1.9	6.9	5.0	24.9	26.3
5	23.4	22.4	−1.0	5.7	5.4	0.3	9.5	5.4	−4.1	24.4	24.1
6	20.4	24.3	3.9	5.3	7.1	1.8	5.7	12.2	6.5	26.0	29.2
7	18.8	19.9	1.1	4.4	5.1	0.7	2.1	4.3	−2.2	23.4	25.6
8	24.2	23.1	−1.1	5.6	5.5	−0.1	12.7	9.5	−3.2	23.1	23.8
9	23.0	27.0	4.0	5.6	9.2	3.4	9.1	24.0	14.9	24.3	34.1
10	23.4	25.9	2.5	5.4	6.4	1.0	9.0	20.5	11.5	23.1	24.7
11	21.6	25.4	3.8	4.9	5.9	1.0	5.3	18.4	13.3	22.7	23.2
12	19.3	20.3	1.0	4.9	4.7	−0.2	3.6	1.5	−2.1	25.4	23.2
13	20.2	23.9	3.7	5.3	5.9	0.6	5.2	14.5	9.3	26.2	24.7
14	23.2	24.6	1.4	5.0	5.9	0.9	8.3	14.4	4.1	21.6	24.0
15	24.5	28.8	4.3	5.6	7.3	1.7	13.8	40.4	26.6	22.9	25.3
16	22.5	22.6	0.1	4.0	4.8	0.8	2.9	6.7	3.8	17.8	21.2
17	21.9	25.0	3.1	4.4	5.5	1.1	4.4	16.8	12.4	20.1	22.0
18	25.2	28.0	2.8	4.3	5.3	1.0	10.2	31.1	20.9	17.1	18.9
19	18.7	27.8	9.1	3.8	6.5	2.7	1.1	31.9	30.8	20.3	23.4
20	23.3	27.6	4.3	5.1	6.7	1.6	7.5	27.6	20.1	21.9	24.6
21	20.0	26.7	6.7	5.2	5.5	0.3	4.2	23.5	19.3	26.0	20.6
Avg.	21.8	24.8	3.0	4.0		1.09			10.8		

instance when there was a difference between a registry and importer's test results from samples taken only 45 days apart, it was found the registry had sampled from the midside point and the importer had sampled from the hip, contrary to the recommended sampling location, which added to the discrepancies.

FIG. 3

Table 26.1 Ranking alpacas for fiber diameter at five years of age.

Age at Measurement	Accuracy of Prediction (%)
Cria	67
2 year old	92
3 year old	96
4 year old	95
5 year old	100

There is one more significant caution in comparing samples from the same animal to get a fix on how fast its fleece is changing. It is worth remembering that the fiber diameter of individual fibers along a staple can vary up to 9 microns if the alpaca has undergone significant dietary changes, or other forms of stress, during the 12-month fleece-growing period. Consequently, if a sample is taken an inch (2.54 cm) from the skin, the result may be significantly different from that of a sample taken close to the skin. In fact, procuring a sample one-half inch (1.3 cm) along the staple from the skin may result in a difference of several microns, depending on numerous environmental factors that the animal may have experienced. The OFDA2000 instrument measures fiber diameter variations along the length of the staple.

Finding the Animal Whose Fleece is Not Affected by Diet

There is no doubt that micron counts will likely increase with a richer diet, but that is not always the case. Of the twenty-one animals in my Peruvian study group, five increased in microns only slightly and two actually decreased ever so slightly in average microns, even though the animals rapidly increased their body weight. Micron reductions from stress and diet are well-documented in alpacas. Animals that are starved or are ill over a period of time will experience micron reduction (Caution: these animals may also succumb to a host of nutritionally based health problems if their health needs are neglected). The subgroup to look for among the healthy animals with solid body scores are the ones who appear to have a genetic predisposition to "resist" fiber coarsening even after the diet is enriched for a substantial period of time. Alpacas whose dietary intake does not appreciably alter their average micron count will undoubtedly attract the attention of breeders and researchers in the years to come.

One such example is a third generation product of North American breeding of alpacas with Chilean ancestry. For reasons appreciated but not understood, the animal defied an enriched diet, aging and multiple shearings. She averaged 19 microns at 18 months of age with a standard deviation of 3.4. Four babies, five shearings and six years later her micron count had not changed.

Predicting Fleece Quality

At what age in an animal's development can the fleece quality be accurately predicted? While working for AgResearch in New Zealand, George Davis MagrSc, DSc collected data from the progeny of a large herd and monitored how their fleece changed over time. He concluded that a fiber sample taken for a histogram before an alpaca is shorn as a tui (14 to 18 months) is less apt to be an accurate indicator of future fleece quality than a histogram based on a sample taken at two years of age from the regenerated fleece following the first shearing. In other words a very good looking histogram attributed to a yearling is not necessarily an indicator of good things to come, while a histogram from a two year old alpaca will usually be a good indicator of future fleeces (See Fig.3).

One of the challenges for camelid breeders is to understand the effects of diet while always keeping in mind the animal's overall health. Too lean a diet may be counterproductive to herd health. Undoubtedly genetics is an important aspect of improving fiber, but understanding and accepting the inevitability of dietary influences and aging should be part of every breeder's calculations. The challenge facing alpaca breeders is not in creating an animal with fiber diameter between 17 and 20 microns at 18 months of age. The difficult challenge is creating a herd of healthy animals that coarsen slowly and average below 26 microns for their first 6 to 8 years while reproducing and maintaining healthy body scores.

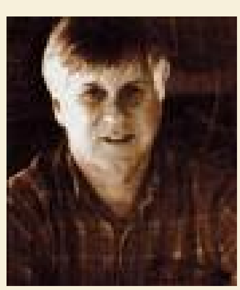
CQ

Credits

Fig. 1 - The British Llama and Alpaca Association (2003). The Complete Alpaca Book, p. 562.

Fig. 2 - Hoffman, Eric (2003).. The Complete Alpaca Book, p. 275

Fig. 3 - Davis, George (2003).. The Complete Alpaca Book, p. 547.



About the Author

Eric Hoffman is the primary author of the Complete Alpaca Book, a 600 page textbook about all aspects of alpacas that has been favorably reviewed around the world. Eric was the founding two term President of AOBA, created the first DNA based camelid registry in the world, continues to work in South America as a screener for entities around the world, and has produced more than 150 articles on camelids, soame appearing in the San Francisco Chronicle, Outside, International Wildlife, Animals, Living Planet, and Wildlife Conservation. He is past editor of The Alpaca Registry Journal and is a regular contributor to CQ Magazine.