Terroir: How Selection Based on Follicle Density Yields Better Fineness and Uniformity

BY KEN ROSENFELD & JULIE ALVARADO ROSENFELD

terˈwär/ noun

- *The complete natural environment in which a particular wine is produced, including factors such as the soil, topography, and climate.*
- *The characteristic taste and flavor imparted to a wine by the environment in which it is produced.*

goût de terroir; *plural noun:* ***goût de terroirs***

"Alpaca breeding is remarkably similar to wine making... it's all a matter of 'terroir.'"

Years ago I read "The Great Wine Book" by Jancis Robinson, which is a "bird's eye view" of "the finest wines from the most renowned vineyards of France, the United States, Germany, Italy, Spain and Australia."

That covers a lot of territory. It was a masterful tome. As it turns out, the elite wine world looks for the same recipe: sunshine, water, and most of all, soil.

Twenty years later I might have benefitted from the current interest on cable television, and HGTV in particular, on hobby vineyards. The obsession I had with wine might have been sated by one of the many shows that deal with interests as diverse as building log homes, wilderness retreats, and barns, or finding the perfect boathouse.

At long last we have as a resource, "I Bought the Vineyard." It's a program featuring enthusiastic young couples seeking to try their luck turning passion into lifestyle by becoming vintners, and usually on parcels of less than 10 acres. With a click of the remote, it is now possible to revisit the yearnings of two decades ago. The first episode featured a soon-to-be-wedded couple who bought a property just a few miles from our ranch.

It turns out that three planted acres in grapes will provide you with 250 cases of wine per year. When we looked into it several years ago, it would have cost $25,000 per acre for a harvest that would wait at least three years. Then it would have to be put in casks and aged in a cellar. That would definitely not work, especially if I was to share my bounty with the volunteers that might line up to help us stomp. Our 10-acre paradise would have to be repurposed. A course adjustment would be in order.

Alpaca breeding is remarkably similar to wine making…it's all a matter of "terroir." My mind flashes to the 1954 hit by the Gaylors, "From the Vine Came the

The author's suggest uniformity in a grey fleece is best measured through follicle testing. RR Sarah Vaughan's fleece, tested at 3.4 years of age, showed the following results: Follicle density: 72.8/ cm2; Secondary/ Primary Ratio: 11.7:1; "In skin" mean primary fiber diameter: 24.4 SD 2.8; "In skin" mean secondary fiber diameter: 18.7 SD 2.9.

A punch tool is used to take a small sample of skin for analysis. In a real biopsy the fleece would be shorn to the skin first. Here, the authors demonstrate how the tool is used. Photos courtesy of Julie Alvarado Rosenfeld

Table 1. **Biopsies through four generations to a line selected by skin biopsies**

Generation 1	**Herdsire 1 (LRG)**	**X**	**Dam 1(DF)**
	(55.9/ 1.2) *		(51.9, 7.9)*
	* Jim Watts (Australia), no other data provided		
Generation 2	**Herdsire 2 (son) (DF)**	**X**	**Dam 2 (DF)**
	(78.3/ 11.2/ 27.5 (3.6)/19.6 (3.3))		(38.6/ 8.6/ 37.8 (6.5)/ 24.7 (13.1))
Generation 3	**Herdsire 3 (grandson) (DSG)**	**X**	**_____**
	(64.6/ 11.8/ 27.5 (3.6)/ 20.6 (2.8))		
Generation 4 (great-grandcria) - see chart below:			

Name of Offspring	Dam Name	Dam Stats	Age at Bx	Color	Sex	Density /mm2	S/P Ratio	In Skin Mean Primary Micron	In Skin Primary SD	In Skin Mean Secondary Micron	In Skin Secondary Micron SD	P-S (Micron)
MALE	a (Dark Brown)	23 mo 59.4/11:1/ 26.2(4.1)/ 20.5(2.8)	32 mo	DRG	M	50.8*	12.1	28.5	3.4	25.8	3.5	2.7
FEMALE	b (Medium Brown)	56 mo 60.2/10.8/ 26.2 (3.4)/ 21.8 (3.1)	31 mo	DRG	F	72.8	11.7	24.4	2.8	18.7	2.9	5.7
FEMALE	c (Medium Fawn)	23 mo 89.3/11.1/ 25.5(3.8)/ 20(2.8)	24 mo	MF	F	72.7	11.4	24.7	2.8	21.0	2.9	3.7
MALE	d (Medium Fawn)	30 mo 50.3/10.3/ 19.7(2.7)/ 14.1(2.2)	20 mo	MSG	M	68.9	10.5	25.0	3.3	20.7	3.0	4.3
MALE	e (Dark Fawn)	19 mo 64.6/12.3/ 20.2(2.9) /14.0 (2.1)	19 mo	MRG	M	61.8	10.8	26.8	3.6	23.8	3.3	3.0
FEMALE	F (Medium Fawn)	26 mo 59.6/11/ 28.6(3.2) /23.5(3.2)	30 mo	MRG	F	71.4	12.4	27.0	4.0	21.4	3.4	5.6

Table 2. **Comparison cria to parents, 4th generation**

Density (/mm2)	S/P Ratio	In Skin Mean Primary Micron	In Skin Primary SD	In Skin Mean Secondary Micron	In Skin Secondary Micron SD	P-S (Micron)	
66.4	11.5	26.1	3.3	21.8	3.1 *	3.9	CRIA Average
63.9	11.1	24.9	3.4	18.1	2.6*	4.6	DAM Average
64.6	11.8	25.9	2.8	20.6	2.8	5.3	SIRE 3 (Grey)
78.2 **	11.2	27.5	3.6	19.6	3.3	7.9	SIRE 2 (Fawn)
55.9	10.2	-	-	-	-	-	SIRE 1 (Grey)

* 5/6 cria grey. None of dams are grey.

**Rank 10/536.

Grape…(from the grape comes the wine…"). My rendering, which, of course, will preoccupy my mind until sunset, will be "From the Skin Comes the Hair" (and, of course, the nails and tusks). Hair is dead, and unlike wine, does not improve with age. It's not "all about the fiber," it's "all about the epidermis."

After hearing Jim Watts speak on the Soft Rolling Skin breeding concept, used for some time in Merino sheep and subsequently in alpacas, in Australia from the late 80s, we became interested in skin follicle testing as a breeder's selection tool.

In essence, the theory is that as the skin organizes in the embryo, its matrix of connective tissue organizes hair follicles dispersed in a finite space as the fetus develops into the third trimester. The stronger the genetic message to initiate new follicles, and the more robust the maternal third trimester health, and compensation for a rising nutrition level, the more the follicles (particularly primaries) would be initiated and sustained.

According Jim Watts (personal communication), there is a critical window of 10 days that is of key importance. Crowding of follicles, as with cultivation, would result in longer, narrower fibers, and a more uniformly arranged and organized staple. Denser concentration of follicles would result in thinner skin, ergo, Soft Rolling Skin. It made sense scientifically. The hypothesis has been proven in Merino sheep, and Jamie Hicks' Coolaroo Alpaca herd in Australia has been using SRS technology in selection with excellent success since 1995.

Though we had been doing histograms, we wondered whether follicle testing would be a better selection strategy in our program. Some of the initial biopsies in our early foundation alpacas were pretty low, even by the norm of the day. We performed those biopsies not just on both sire and dam, but also on the next generation.

Based on those biopsy results, we were convinced we could pick our strongest candidates earlier than we otherwise would by using progeny outcomes. We hoped to perhaps bring about quicker genetic gain in our herd, providing we could place confidence in our analytics.

DISCUSSION:

Most of our herd under age 2 has been biopsied. For convenience and clarity, we have decided only to outline our emerging fourth generation progeny results as influenced by selection using follicle testing through a male line.

A pair of grey offspring, the fourth generation chosen using follicle density as a selection tool, graze at the Renaissance Ridge ranch.

Photo courtesy of Julie Alvarado Rosenfeld

We believe that a few points are important in interpreting the data:

- The population described is a colored alpaca population, fawn through grey to black. Individual members, we believe, have to be assessed in light of color. The disparity between white and black fiber density, established in databases by color, is well known. While it is likely that differences are a result of more intensive breeding for white historically, it is not unlikely that there is a contribution as a result of development with eumelanin, as compared to phaemelanin, in the initiated follicles' survival.*

- Grey is a compound color. Our first sire biopsy did not have fiber metrics for primaries and secondaries provided, but did have analysis of dark and light fiber percentages within those populations. It is possible to have almost 100 percent in either population in greys. His was close to half in each, something we believed might predispose to uniformity of color. The two pigments have different curvatures and therefore "crinkle." It is for that reason we prefer using the Primary-Secondary ratio and respective standard deviations in those fiber populations, rather than the histogram-derived Standard Deviation in looking for uniformity in a grey population, at least in a grey breeding program.

- Pursuant to item 2, much as there are member color differences through the generations, there are differences between generations. As an example, the numbers for dam averages (Table 2) reflect fawn, brown, and black alpacas, but no grey. The averages for cria are from a population that that is 5/6 grey. It is for that reason we are satisfied to take a small hit in micron at the expense of P-S and population SDs, as might be seen in Table 2. That shift can also be appreciated in selecting for a less dense son, with otherwise better uniformity in shift from sire 2 to 3. That choice was based on color selection, as well.

- The very high density in sire #2 is anomalous. He currently ranks 10th in a database of 536. His was the very dramatic difference in metrics over either parent that encouraged us to continue breeding along this line. We would never have, for better or worse, made that decision absent follicle testing.

This fourth generation still awaits 17 other offspring biopsies, but they are too young to biopsy as of the date of this article. Most of the dams have been re-bred two to three times, so we can ultimately do comparative results of repeated matings and look at the dam's contribution. Maternal genetics contribute to follicle proliferation and account for S/P ratio, both by heritable tissue differentiation, but also by a propensity to sustain good health despite close consecutive breedings and lactation. We are well into our fifth generation of this line, but it will be a couple of years before they are ready for biopsy.

CONCLUSIONS

While six offspring biopsies is a somewhat small sample size for this fourth herdsire, we feel the results are close enough in consistency to suggest support for follicle density as a selection tool to also select for fineness and uniformity. It is worth noting that herdsire 2 is anomalous in that density. Our results, nevertheless demonstrate a significant, and sustained increase in follicle density in both subsequent male generations and the contributing averages in dams that have likewise been selected for density.

It is not surprising that Table 2 does not show continued micron improvement through generation 4. We interpret that to be a result of re-adjusting our breeding focus to P-S and SDs in those fiber populations in generation 3, and then a shift to grey color in generation 4. The data is further complicated by linebreeding in generation 4. This doesn't negate the benefit of enabling selection along those priorities, in a way that afforded more agility.

Skin follicle testing allows one to adjust selection preferences as it has over the course of our experience, when we made a deliberate decision to include color into our selection mix. The data would be expected to be of greater significance statistically in looking at a uniform white herd.

Consultant Ian Watt has reported on high correlation coefficients between skin thickness, density and "in skin micron" in a contemporaneous population (personal communication). This report is offered as a longitudinal study, in progress, that supports the SRS hypothesis as a tool for selection in improving density and staple length across a herd, while supporting and improving micron and uniformity. We now rely more on other metrics revealed in a skin biopsy, rather than focusing on density alone.

We believe that S/P has a greater maternal than paternal influence. Maternal influences not only select for a propensity to encourage new growth, but also for the robust good health to carry a pregnancy for most of a year, but then compound the nutritional demands by several more months of lactation. As a better appreciation for appropriate nutrition is gained in the first trimester and early weeks of gestation, we can expect to predict better S/P ratios.

* Melanosomes are, in effect, an excretory system. They are minute cell organelles that seal and deliver "secured" toxic waste, such as heavy metals and melanin, which can't be handled by the liver and kidney. It's also, interestingly, how archeologists and forensic investigators look for heavy metal (such as arsenic) poisoning. ■

Renaissance Ridge alpacas was "conceived' several years prior to Julie and Ken Rosenfeld's first alpaca purchases in 2004. It was a pursuit of a dream to "live off the land," but also a challenge to provide a satisfying small business model in retirement in California's "Gold Country." They run 70 or so alpacas on 10 acres, and have been focused on colored huacayas, solid grey in particular. They are among the earliest enthusiasts of skin follicle testing in the U.S., and have been doing it continuously through four generations.