Alpaca Fiber Quality and Analysis

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Texas AgriLife Research

The Texas A&M System

San Angelo

Alpaca Information Day

Petersburg, VA January 17, 2009

Overview

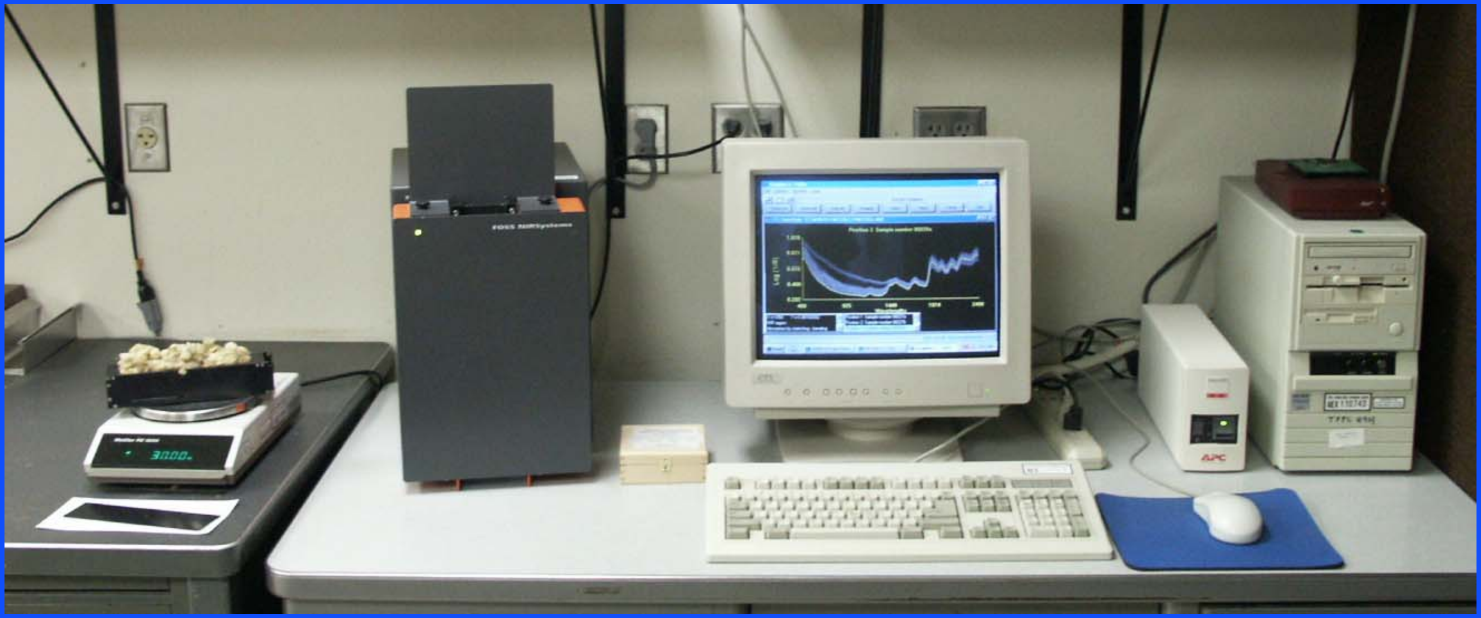
I. Background and current research interests.
II. Recent cooperative studies with alpacas.
III. Animal fiber metrology.
IV. Genetic tools that are being used to improve alpaca fiber quality and production.

Current research objectives

1. **Develop and evaluate *near-infrared reflectance spectroscopy* and *automatic image analysis* for more rapid, less expensive, objective evaluation of animal fibers.**
2. **Use objective measurements to improve fiber and / or meat production, quality, and income to producers through improved selection, nutrition, management, and marketing efficiency.**

I. Current projects at the Wool and Mohair Research Lab, Texas AgriLife Research, San Angelo

- **Near-infrared reflectance spectroscopy for measuring clean yield and fiber properties of greasy wool and mohair.**



Current projects at the Wool and Mohair Research Lab, Texas AgriLife Research, San Angelo

- **Comparison of Texas Rambouillet with Australian Merino F1 crosses**

Current projects at the Wool and Mohair Research Lab, Texas AgriLife Research, San Angelo

- **Using a portable automatic image analysis instrument (the OFDA2000) to measure fiber characteristics at the farm or ranch**

Current projects at the Wool and Mohair Research Lab, Texas AgriLife Research, San Angelo

- Rambouillet ram and Angora billy goat central performance tests

Current projects at the Wool and Mohair Research Lab, Texas AgriLife Research, San Angelo

- **Genetic selection to improve the use of goats to manage juniper**

Current projects at the Wool and Mohair Research Lab, Texas AgriLife Research, San Angelo

- **Genetic selection to develop a more profitable dual-purpose (fine wool and meat) sheep. The Texas Rambouillet Superior Genetics Cooperative Breeding Program / National Sheep Improvement Program.**

II. Recently completed alpaca research projects

- **Fiber characteristics of Huacaya alpacas in the United States**

- Angus McColl, Yocom-McColl Testing Laboratories, Denver.
- Bob Stobart, University of Wyoming, Laramie.
- Chris Lupton, Texas AgriLife Research, San Angelo.

- 23 fiber characteristics, BW, n=585

- Small Ruminant Research, 63, 3:211-224.

Recently completed alpaca research project

- **Determine the effects of age, location, nutrition, and season on fiber production, fiber quality, and body weight of intact alpaca males.**

- **Ruth Elvestad, Olds College, Alberta Canada**
- **Chris Lupton, Texas AgriLife Research, San Angelo**

Location of Research Sites in Canada and USA

Current projects with alpacas

- Gastrointestinal parasite epidemiology and control in alpacas.
- Effects of management practices on alpaca fiber production.
- Stephan Wildeus et al., Virginia State University, Petersburg

Current long-term, low intensity project with alpacas

- Evaluation of alpaca castrates as guard animals for sheep and Angora goats

Another recently funded project with alpacas

- Evaluation of two objective methods (the SAMBA System and NIRS) for measuring luster in Suri alpaca fiber, comparison with subjective assessment, and correlation with other physical properties. A. McColl and C. J. Lupton.

III. Alpaca fiber metrology

"Current technology"

Sampling

- From live animals
- From shorn fleeces
- From accumulations (bags or bales)

Sampling

- Mid side, best single indicator
- Random (core or grid) sample from part of (e.g., saddle) or whole fleece
- Random (core or grab [manual or machine]) sample from packages of fiber

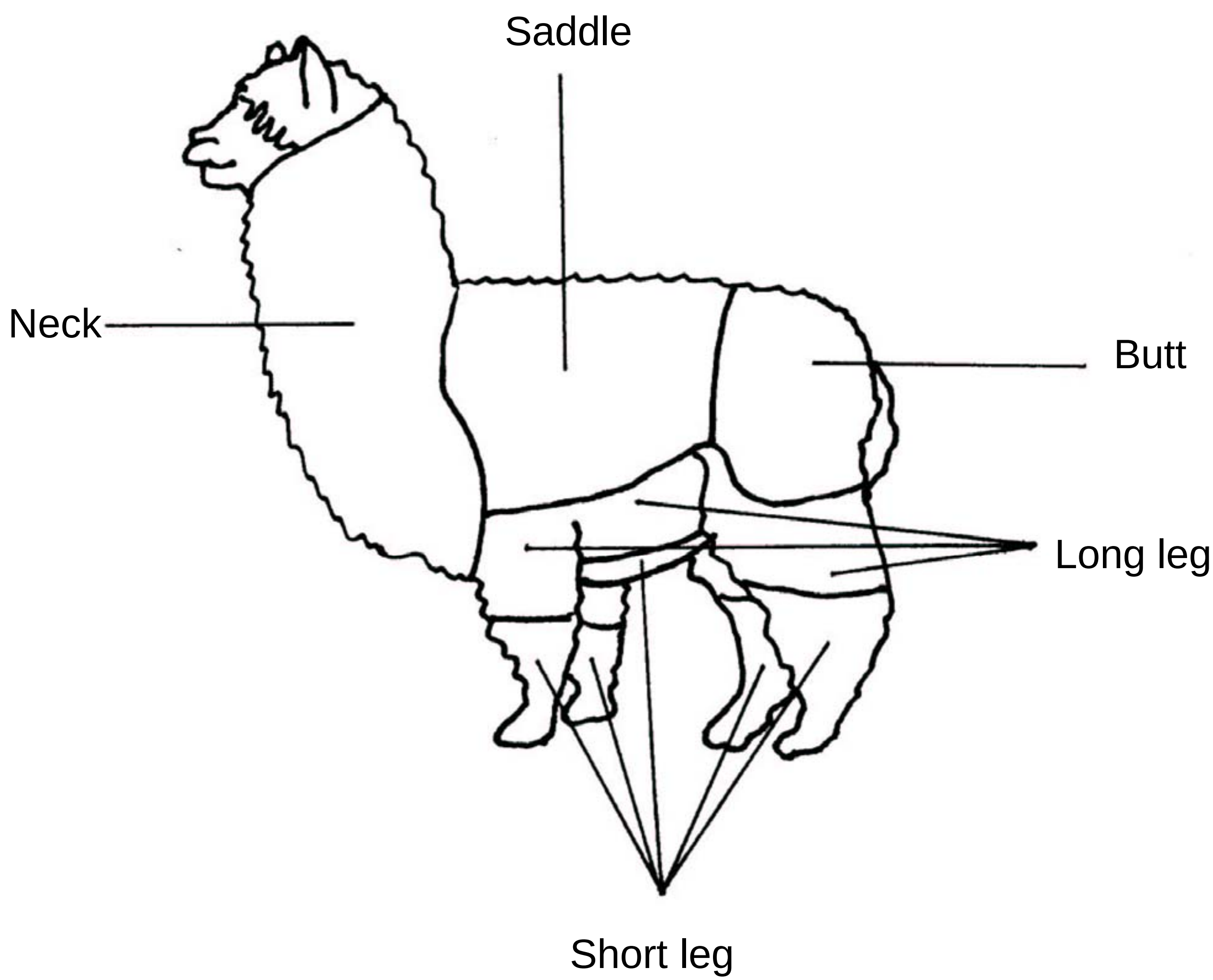
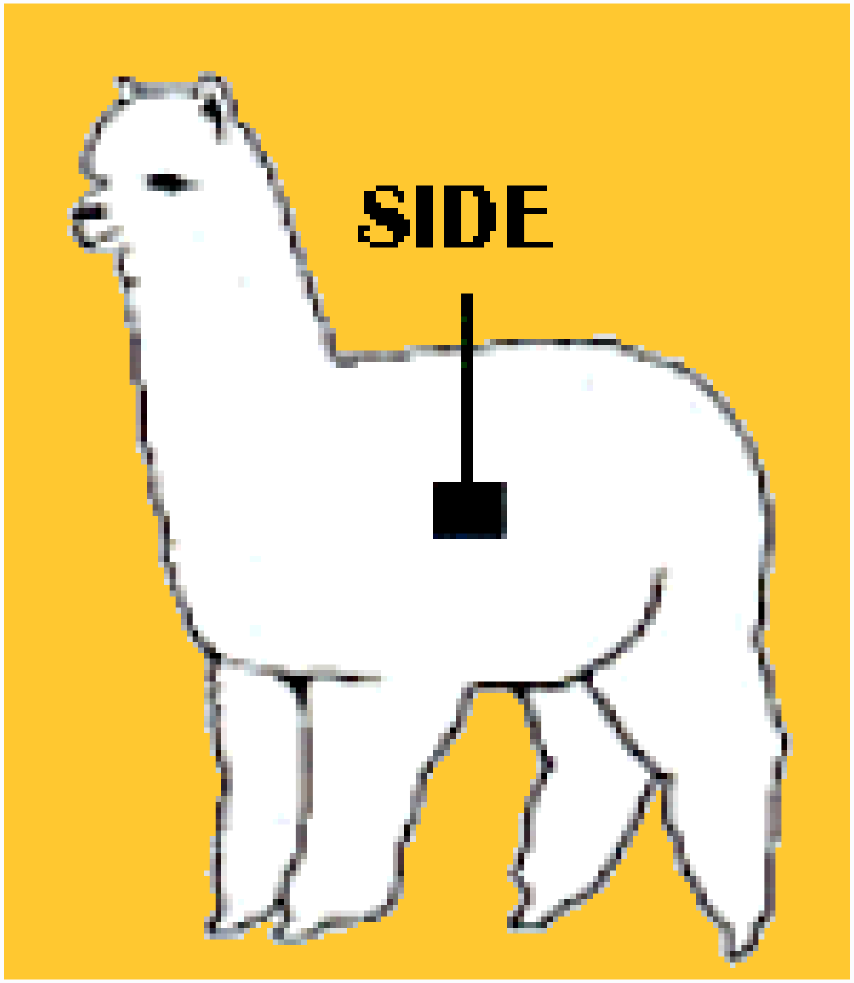


Figure 1. Five (normally) distinct fleece components

Yocom-McColl's alpaca mid-side diagram

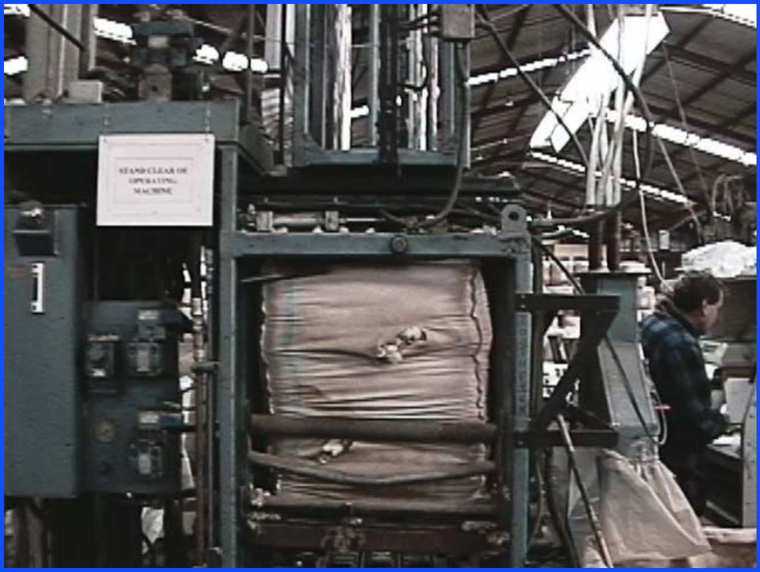


Neck, side, and britch samples for fiber diameter and medullation

[redacted]

Core & grab sampling bales

Core sampling bales



Fleece and fiber characteristics that can be measured or calculated

- Weight (raw and clean; whole or components), kg
- Clean yield, % (AB, LSY, CWFP, SDY)
- Vegetable matter content, % (VMB, VMP)
- Average staple length, SD, mm, and CV, %
- Average staple strength, SD, N/ktex, CV, %, POB (and % tip, middle, and base breaks).

Fleece and fiber characteristics that can be measured or calculated (contd.)

- Average fiber diameter, SD, microns, CV, %
- Comfort factor, % fibers < or = to 30 microns
- Spinning fineness, microns
- Average fiber curvature, SD, deg/mm, CV, %
- Resistance to compression, kPa
- Medullated fibers (med, kemp and total medullation, ASTM), or total medullated fibers, flat fibers, and objectionable fibers, % or number / 10,000 (IWTO). Also AFD, SD, and CV of medullated fibers.

Fleece and fiber characteristics that can be measured or calculated (contd.)

- **Dark fibers (in white fleeces or vice versa), number / 10,000 or number / unit weight.**
- **Color, tristimulus values, brightness or yellowness.**
- **Luster.**
- **Fibers per unit area of skin.**

Relative commercial importance of raw specialty animal fiber traits (McGregor, 2006).

Trait	Scoured	Top/noil	Yarns	Cloth
Mean fiber diameter	****	****	****	****
Comfort factor	-	-	*	***
CV of fiber diameter	-	-	**	**
Clean yield	****	-	-	-
VM (amount and type)	***	***	**	**
Staple strength/ POB	**	*	-	-
Mean fiber length	**	***	**	**
CV of fiber length	**	**	*	*
Dark fibers	*	*	*	***

Relative commercial importance of raw specialty animal fiber traits (McGregor, 2006) contd.

Trait	Scoured	Top/noil	Yarns	Cloth
Medullated fibers	**	**	**	***
Fiber crimp	*	*	**	**
Color	*	-	-	**
Style and handle	-	-	**	**

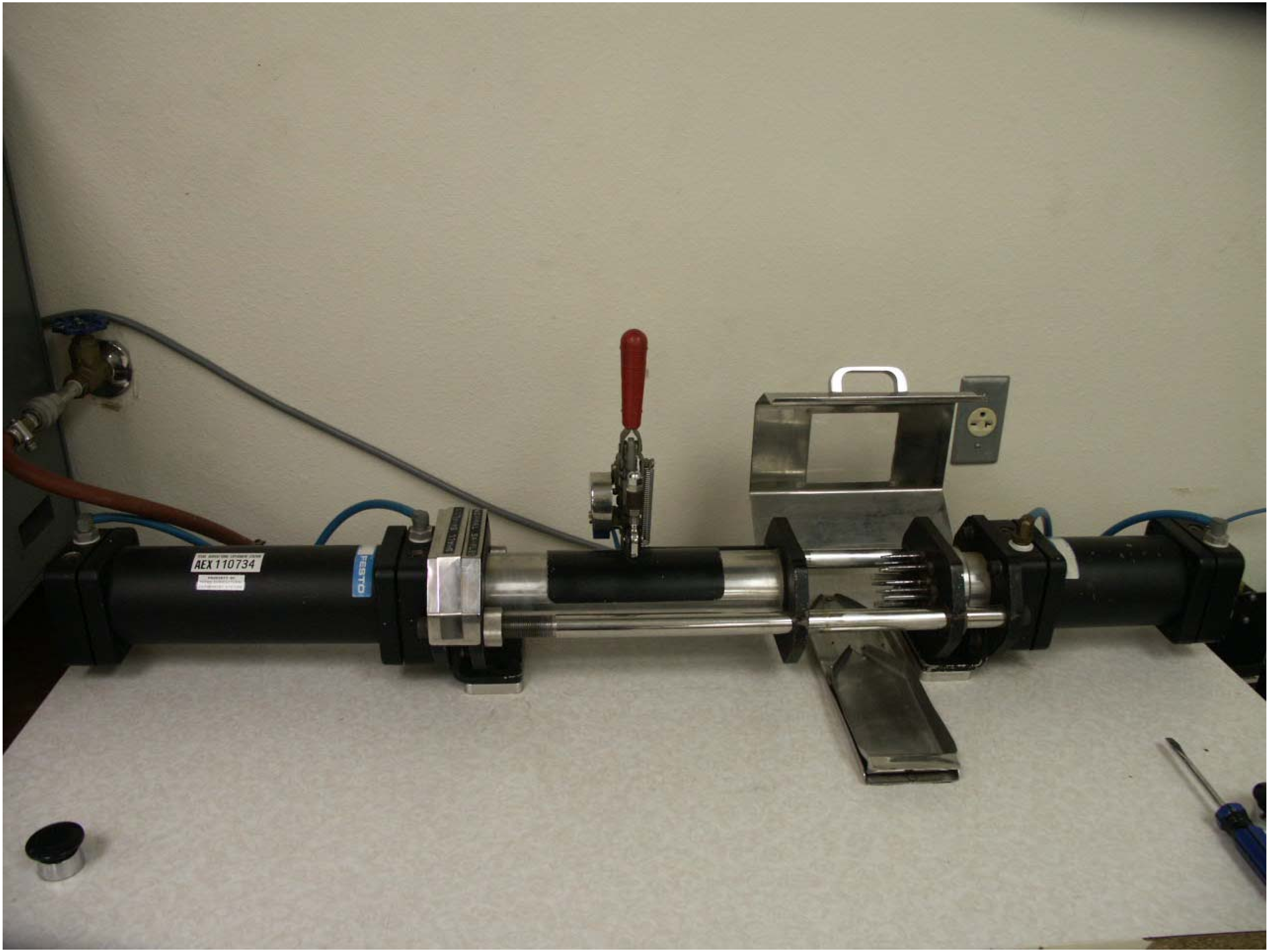
* Some significance
**** Highly significant

Sampling the staple

- Guillotine (2 mm) the base of staple (OFDA 100 or Laserscan).
- Guillotine elsewhere along the staple.
- Measure the whole staple (OFDA2000).
- Minicore the whole staple (2 mm).

- Measuring each type of sub-sample will give you a different result, but all are potentially useful.

Courtesy:
Yocom-McColl
Testing Labs, Inc.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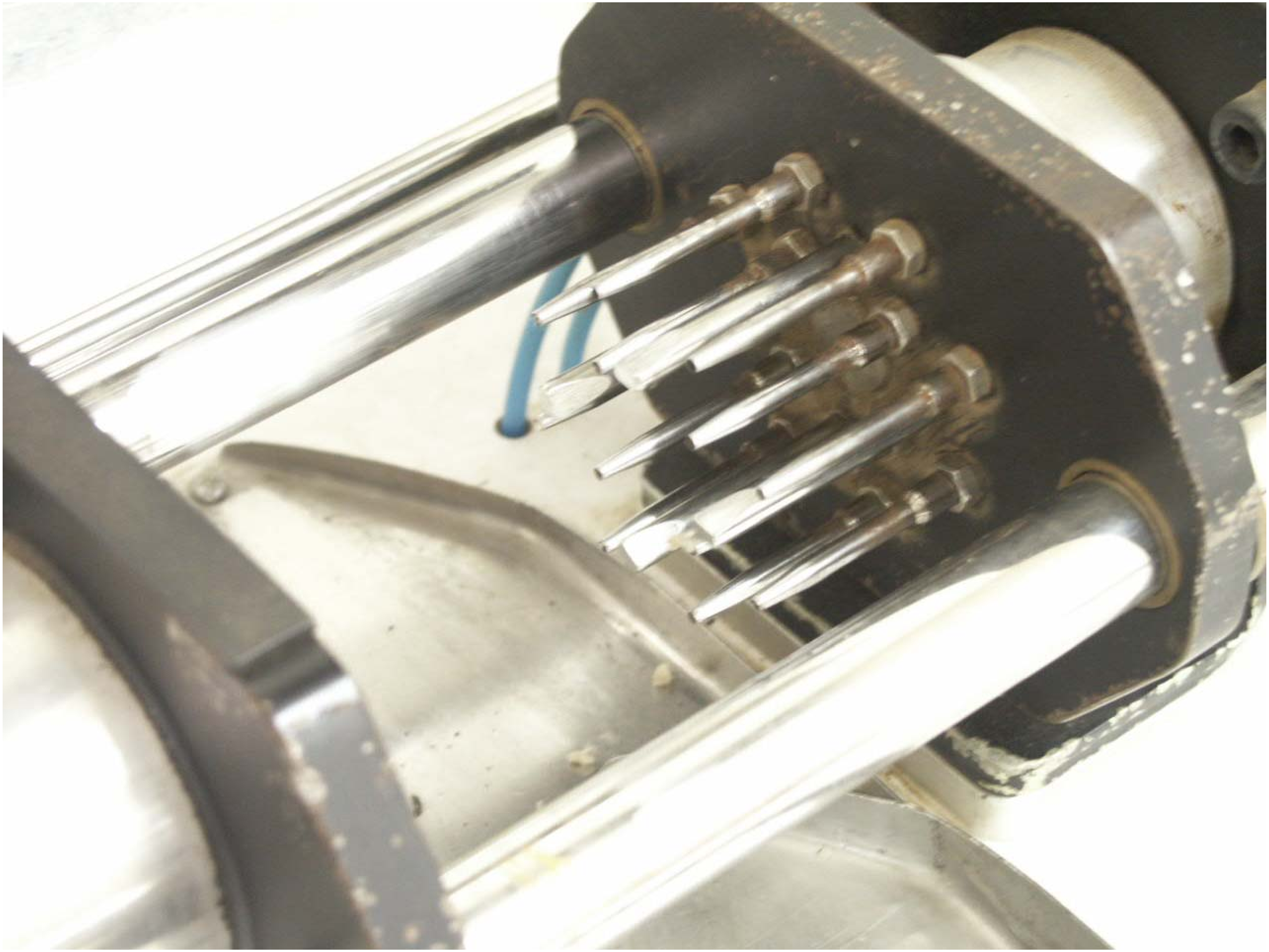



Jeep

Standard methodology

- American Society for Testing and Materials (ASTM)
- International Wool Textile Organisation (IWTO)

Fleece and fiber characteristics that can be measured or calculated

- ✓ Weight (raw and clean; whole or components), kg
- ✓ Clean yield, %
- ✓ Vegetable matter content, %
- Average staple length, SD, mm, and CV, %
- Average staple strength, SD, N/ktex, CV, %, POB (tip, mid, base or fraction)

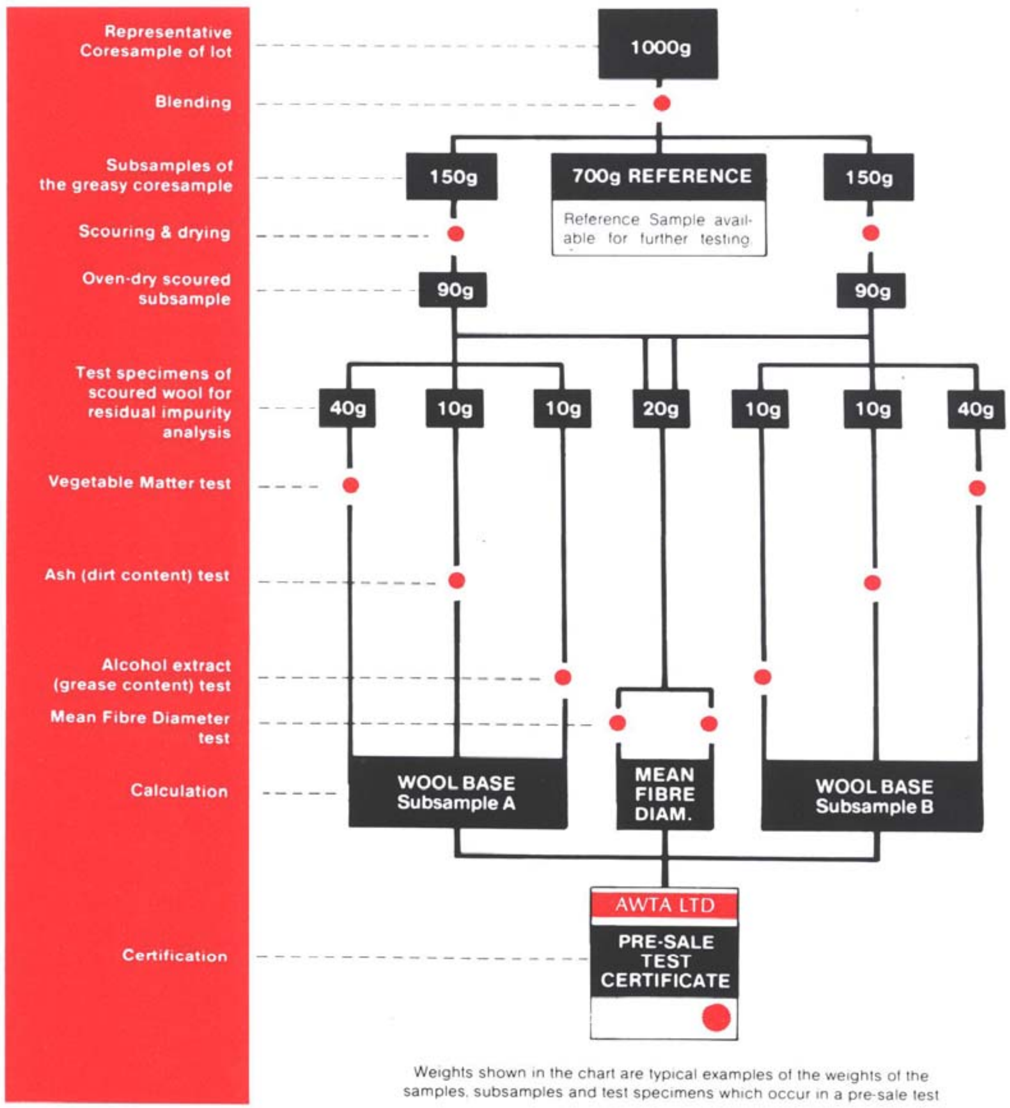
Alpaca fiber base

- Mass of clean, dry fiber with all impurities removed expressed as a % of the original “raw” or “greasy” alpaca fiber mass.
- Usually report the fiber base after adjusting for allowed moisture (12%), residual grease (1.5%) and ash (0.5%).

Vegetable matter base

- Mass of oven-dried scoured burrs, seeds, twigs, leaves, and grasses, free of mineral matter and alcohol-extractable matter expressed as a % of the mass of the sample.

Presale Measurement Procedure



Weights shown in the chart are typical examples of the weights of the samples, subsamples and test specimens which occur in a pre-sale test

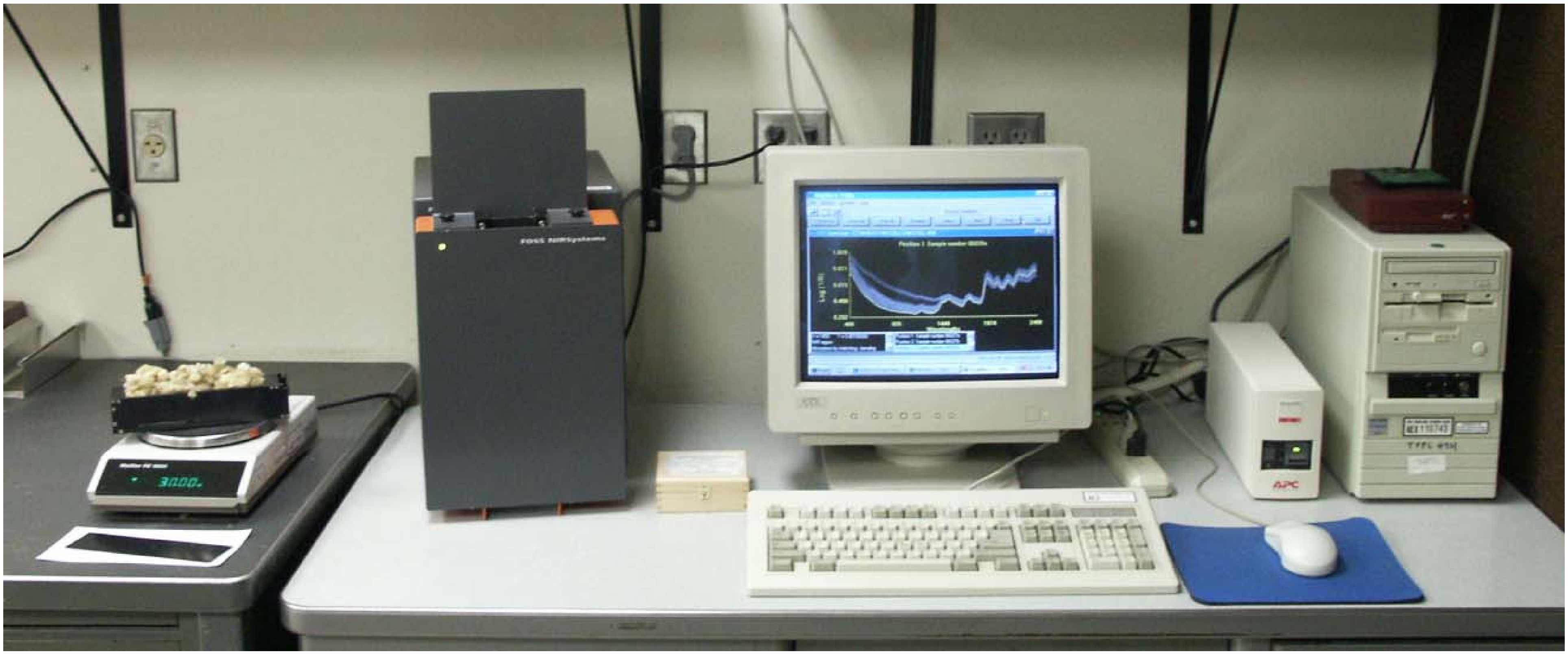
NIRS

- Allows us to quantify broad classes of compounds or individual compounds that contain different chemical bonds.

  e.g., protein (in this case keratin), lipids (wool wax), cellulose and lignins (vegetable matter), and water.

- NIRS is also sensitive to particle size (potential for estimating AFD, SDFD, AC).

Near-infrared Reflectance Spectroscopy



NIRS Measurements

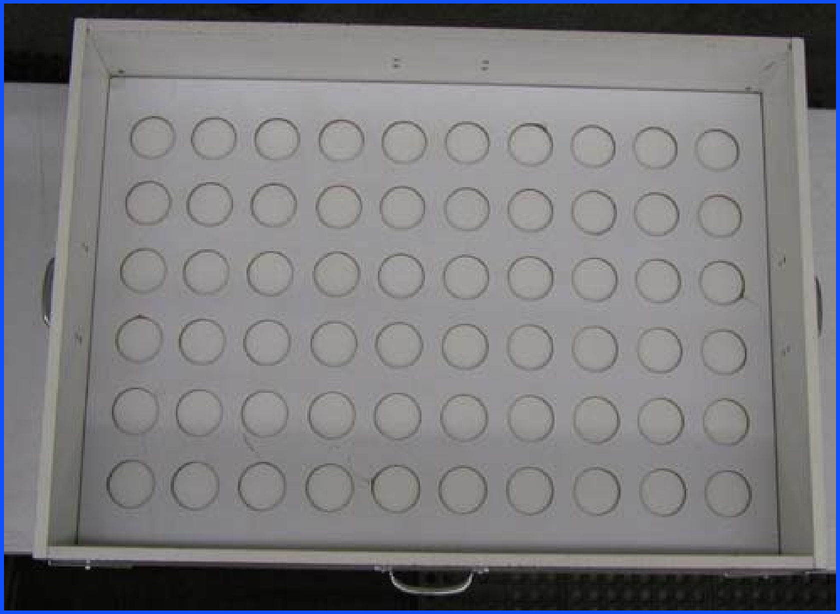
- Non-destructive and results available in less than two minutes.
- Currently, only being used commercially to replace one of the gravimetric tests (residual grease).

Fleece and fiber characteristics that can be measured or calculated

- ✓ Weight (raw and clean; whole or components), kg
- ✓ Clean yield, %
- ✓ Vegetable matter content, %
- ✓ Average staple length, SD, mm, and CV, %
- Average staple strength, SD, N/ktex, CV, %, POB (tip, mid, base or fraction)

Length Measurement, contd.

Grid sampling



Average staple length, SD, and CV of staple length

Length & Strength Testing

Measuring Length

Staples in a Tray

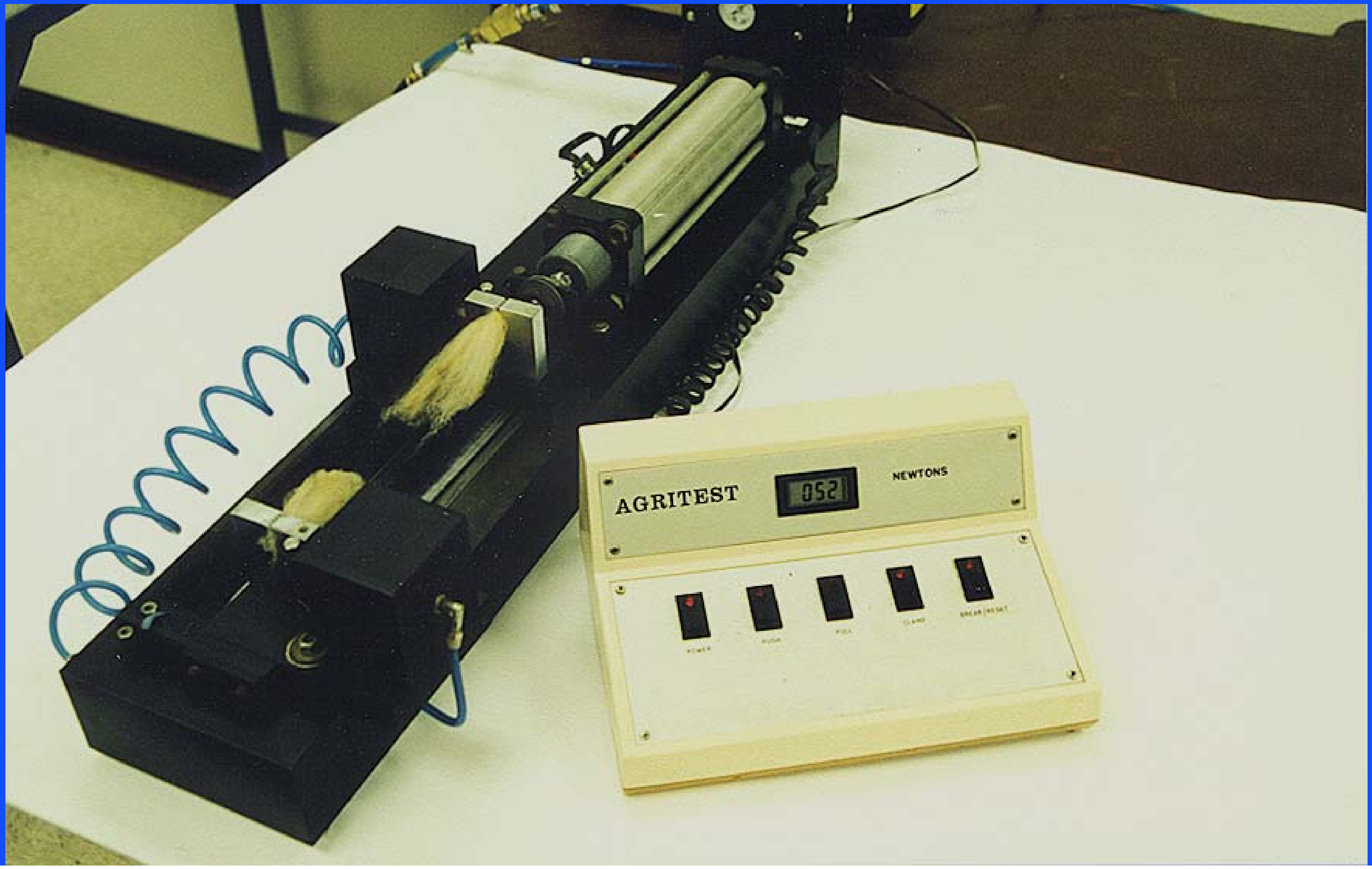
ATLAS

Fleece and fiber characteristics that can be measured or calculated

- ✓ Weight (raw and clean; whole or components), kg
- ✓ Clean yield, %
- ✓ Vegetable matter content, %
- ✓ Average staple length, SD, mm, and CV, %
- ✓ Average staple strength, SD, N/ktex, CV, %, POB (tip, mid, base or fraction)

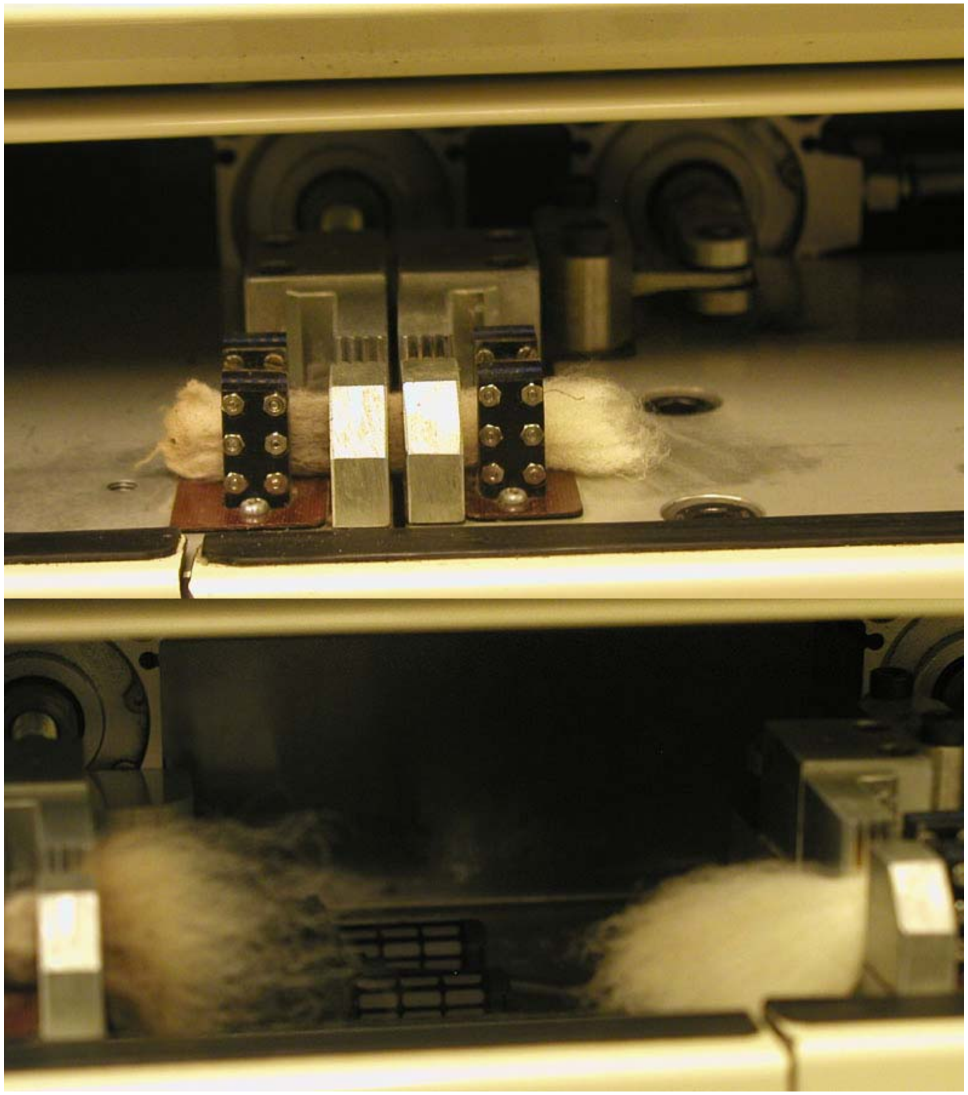
Staple Strength Measurement

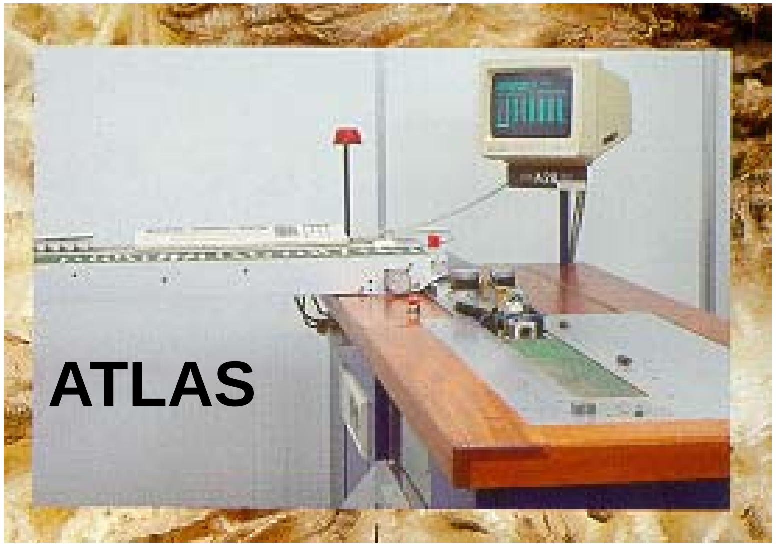
Average staple strength, SD and CV of staple strength, Position of break, and % tip, middle and base breaks



Strength Measurement, contd.

Agritest Staple Breaker 2





Fleece and fiber characteristics that can be measured or calculated (contd.)

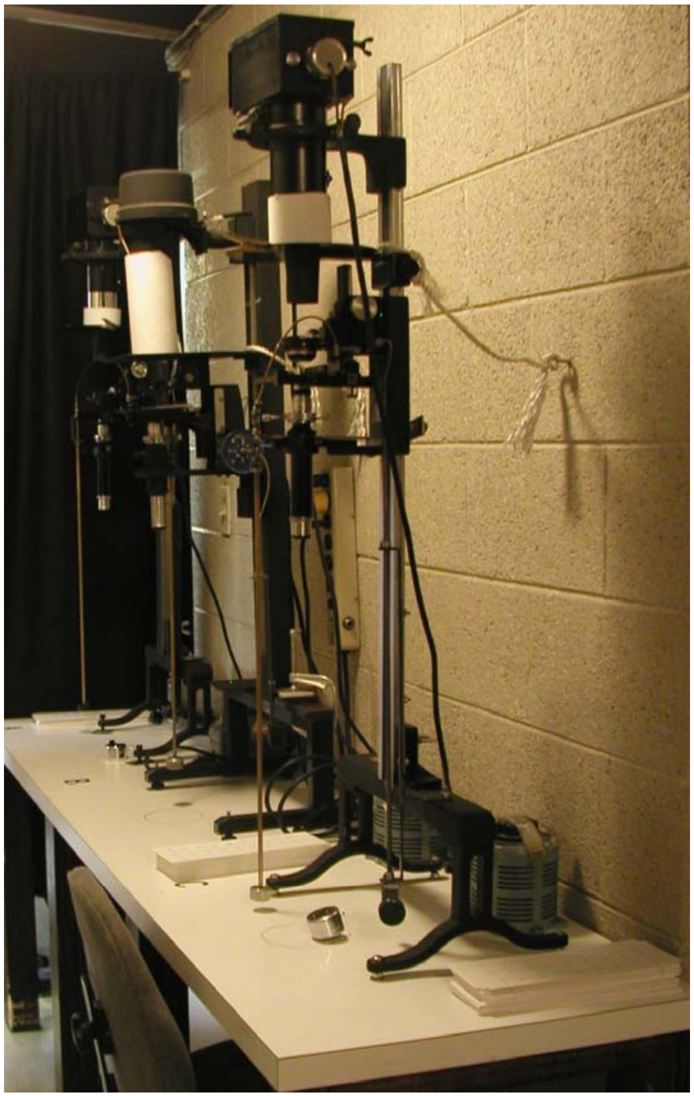
- ✓ Average fiber diameter, SD, microns, CV, %
- ✓ Comfort factor, % fibers < / = to 30 microns
- ✓ Spinning fineness, microns
- ✓ Average fiber curvature, SD, deg/mm, CV, %
- ✓ Medullated fibers (white and pastel fibers only), total medullation, flat fibers, and objectionable fibers, % or number / 10,000.
- Dark and medullated fibers and contaminants (in white fleeces), number / 10,000 or number / unit weight
- Resistance to compression, kPa
- Color, tristimulus values, brightness or yellowness

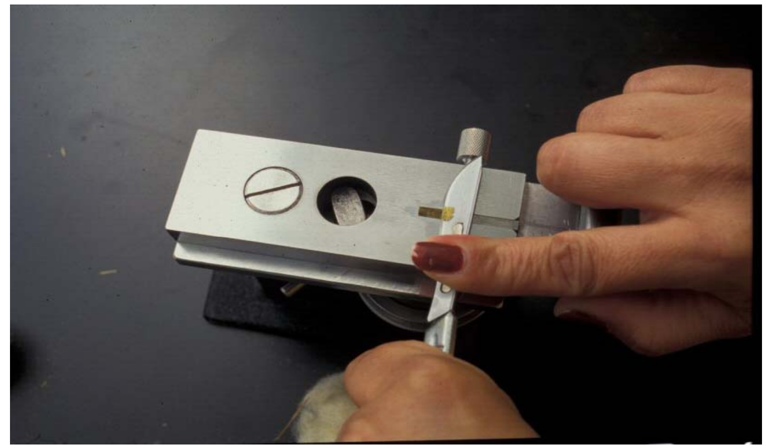
Instruments for measuring average fiber diameter

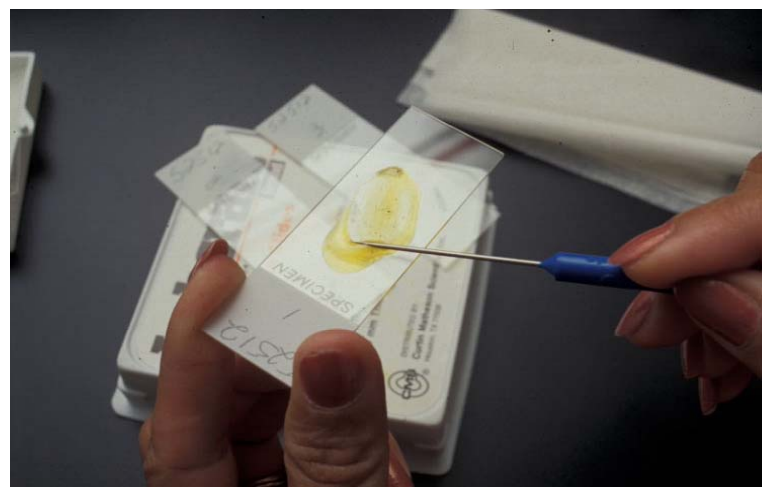
- Projection microscope (PM)
- Sirolan Laserscan (LS)
- Optical Fiber Diameter Analysers (OFDA 100 and 2000)
- Sirolan Fleecescan
- Airflow

Projection Microscope

Courtesy:
Yocom-McColl
Testing Labs, Inc.







Microprojection

**Courtesy:
Yocom-McColl
Testing Labs, Inc.**

One Micron Equals…

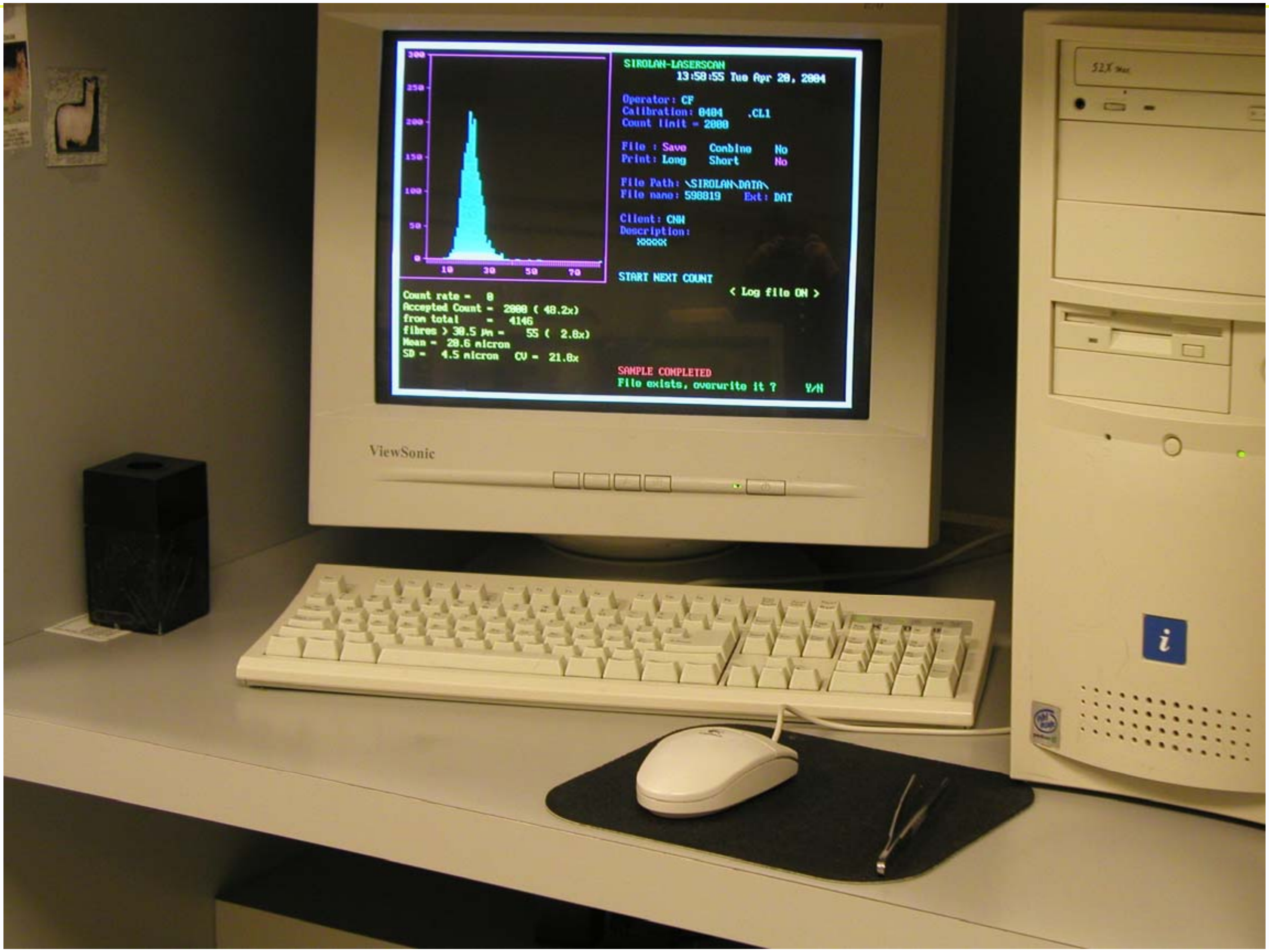
1/25,400 of one inch

or

1/1,000,000 of one meter

Sirolan LaserScan Sample

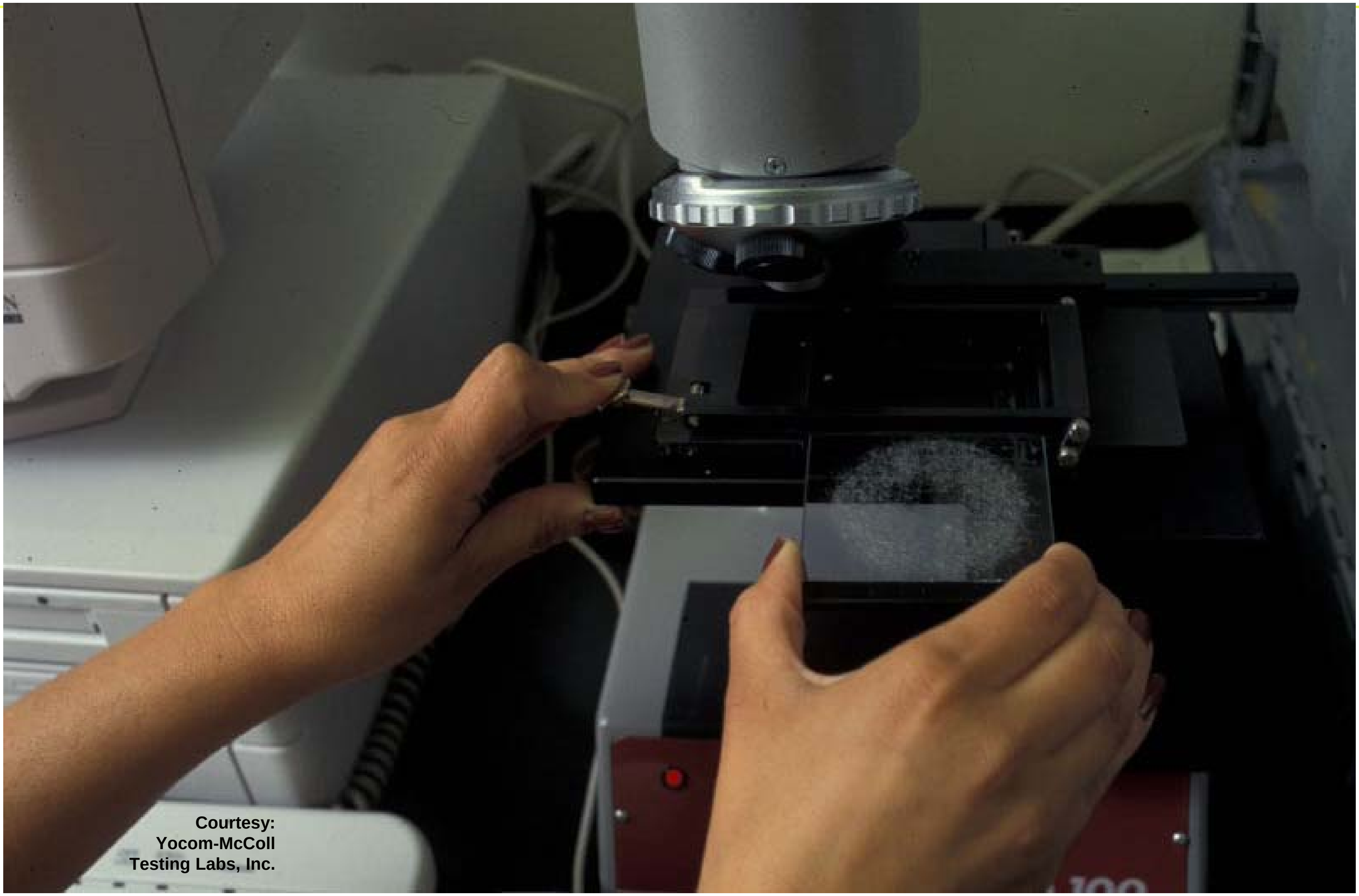
LaserScan Display



Courtesy:
Yocom-McColl
Testing Labs, Inc.

OFDA 100
Optical Fibre Diameter Analyser

OFDA slide on stage



OFDA2000

Sirolan Fleecescan

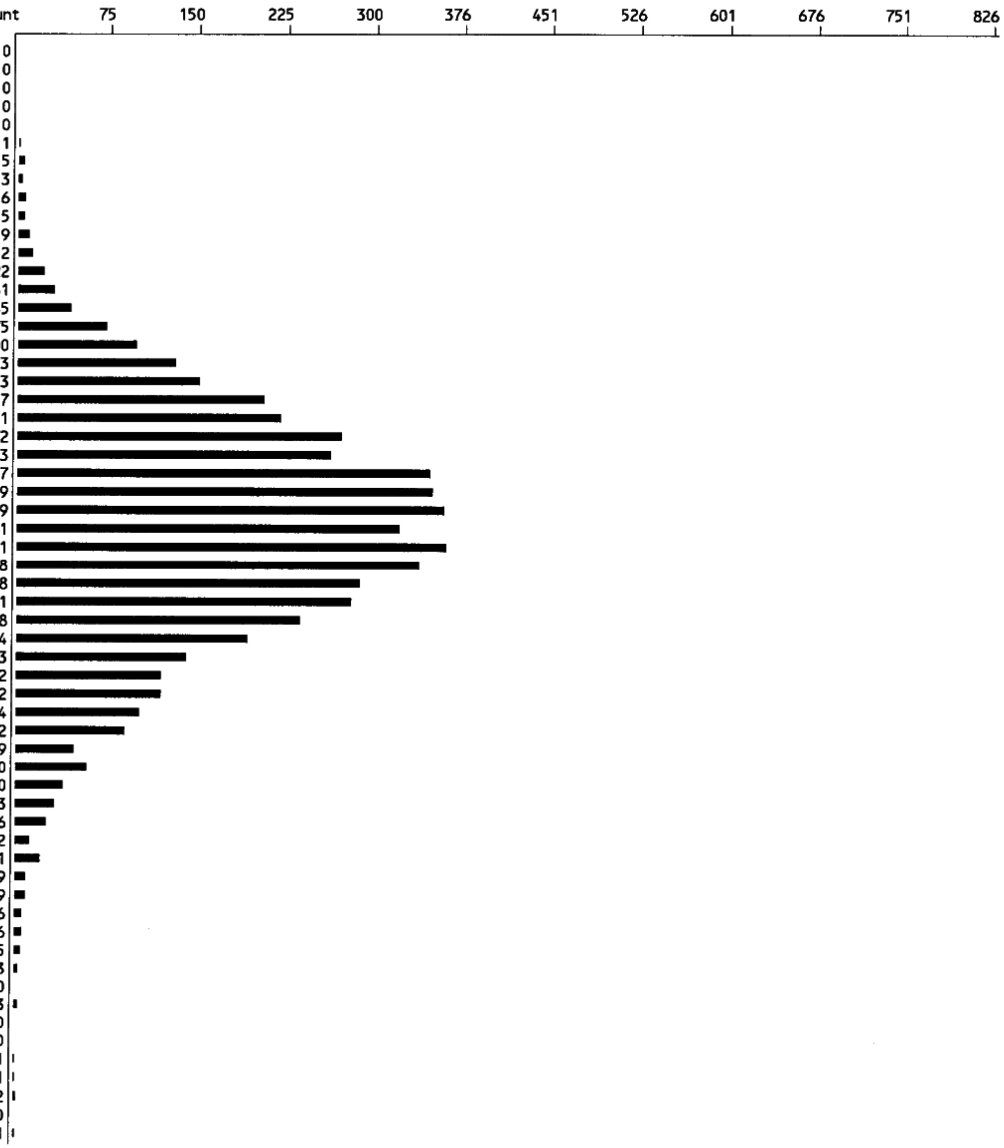
Sirolan Fleecescan

Texas Agricultural Experiment Station

Date	:	13Feb07	Mean	=	27.3 u
Sample ID	:	ALPACA	SD	=	6.6 u
Description	:	232	CV	=	24.3 %
Lot/Client	:	ALPACA FARMS	Sample size	=	5509
Operator	:	CJL	Spin fineness	=	27.3 u
5% of fibres 12.0 u above mean.			Comfort factor	=	71.3 %
Curve= 66.8[43] deg/mm			Curve number	=	3045

OFDA030:2.14 Cal: D=5.4121*WH -3.80, wV= 1.4680*wH+ 0.08, DkFlash= 77.5

cum.%	mic	count
100.0	1	0
100.0	2	0
100.0	3	0
100.0	4	0
100.0	5	0
100.0	6	1
100.0	7	5
99.9	8	3
99.8	9	6
99.7	10	5
99.6	11	9
99.5	12	12
99.3	13	22
98.9	14	31
98.3	15	45
97.5	16	75
96.1	17	100
94.3	18	133
91.9	19	153
89.1	20	207
85.4	21	221
81.3	22	272
76.4	23	263
71.6	24	347
65.3	25	349
59.0	26	359
52.5	27	321
46.7	28	361
40.1	29	338
34.0	30	288
28.7	31	281
23.6	32	238
19.3	33	194
15.8	34	143
13.2	35	122
11.0	36	122
8.8	37	104
6.9	38	92
5.2	39	49
4.3	40	60
3.2	41	40
2.5	42	33
1.9	43	26
1.4	44	12
1.2	45	21
0.8	46	9
0.7	47	9
0.5	48	6
0.4	49	6
0.3	50	5
0.2	51	3
0.1	52	0
0.1	53	3
0.1	54	0
0.1	55	0
0.1	56	1
0.1	57	1
0.1	58	2
0.0	59	0
0.0	60	1



Standard Deviation (SD)

- Statistical measurement of the variability in a sample
- 68% of the fibers fall with in +/- one SD of the mean or average
- Smaller the number, the more uniform the sample

Standard Deviation (SD)

- **Example:**
- **MFD=20 microns**
- **SD=4.0 microns**
- **CV=(4.0/20.0)*100=20%**

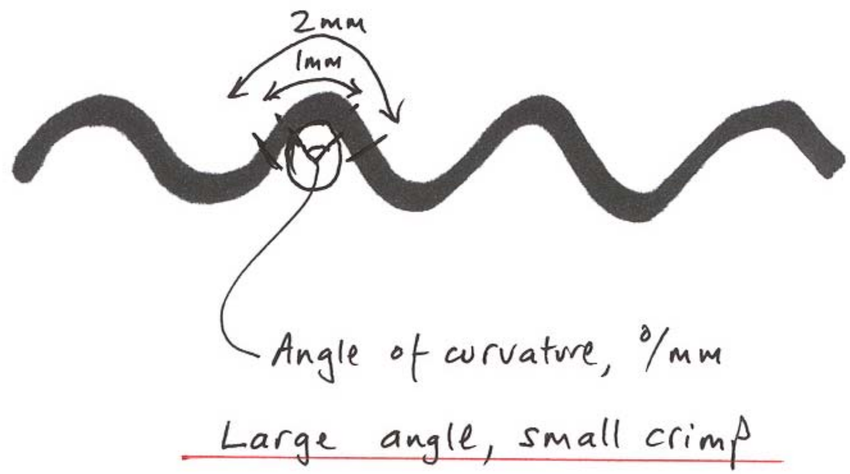
- **Assume "normal" distribution then:**
- **68% of all fibers measured are between 16 and 24 microns**
- **95% of all fibers measured are between 12 and 28 microns**

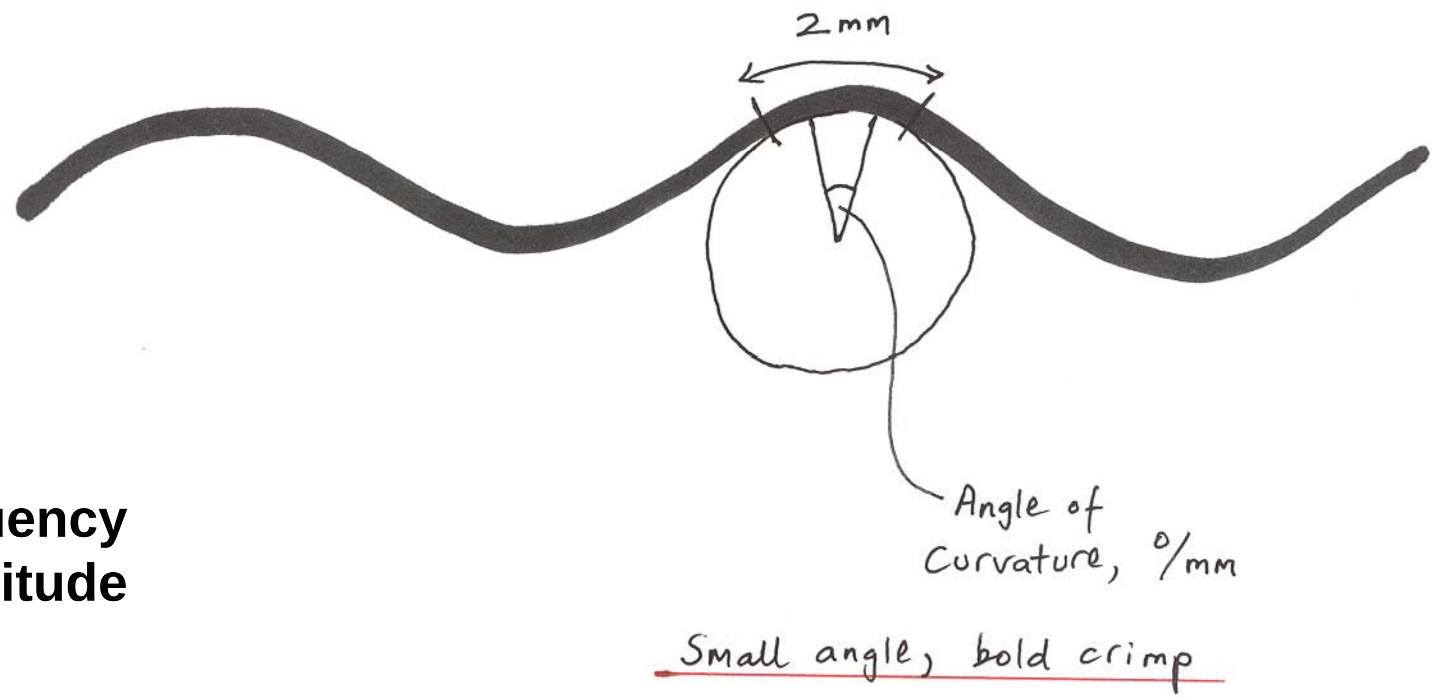
Curvature

- **Is a measurement of the fiber crimp. Does not indicate the type of staple crimp (i.e., uniform staple crimp (like most fine wools) or crinkle (like cashmere).**

- **Is correlated with Bulk and Resistance to Compression**

- **Generally, worsted processors (lean yarns for fine suitings) prefer less crimp, woolen system spinners prefer more crimp (bulkier yarns for knitwear).**



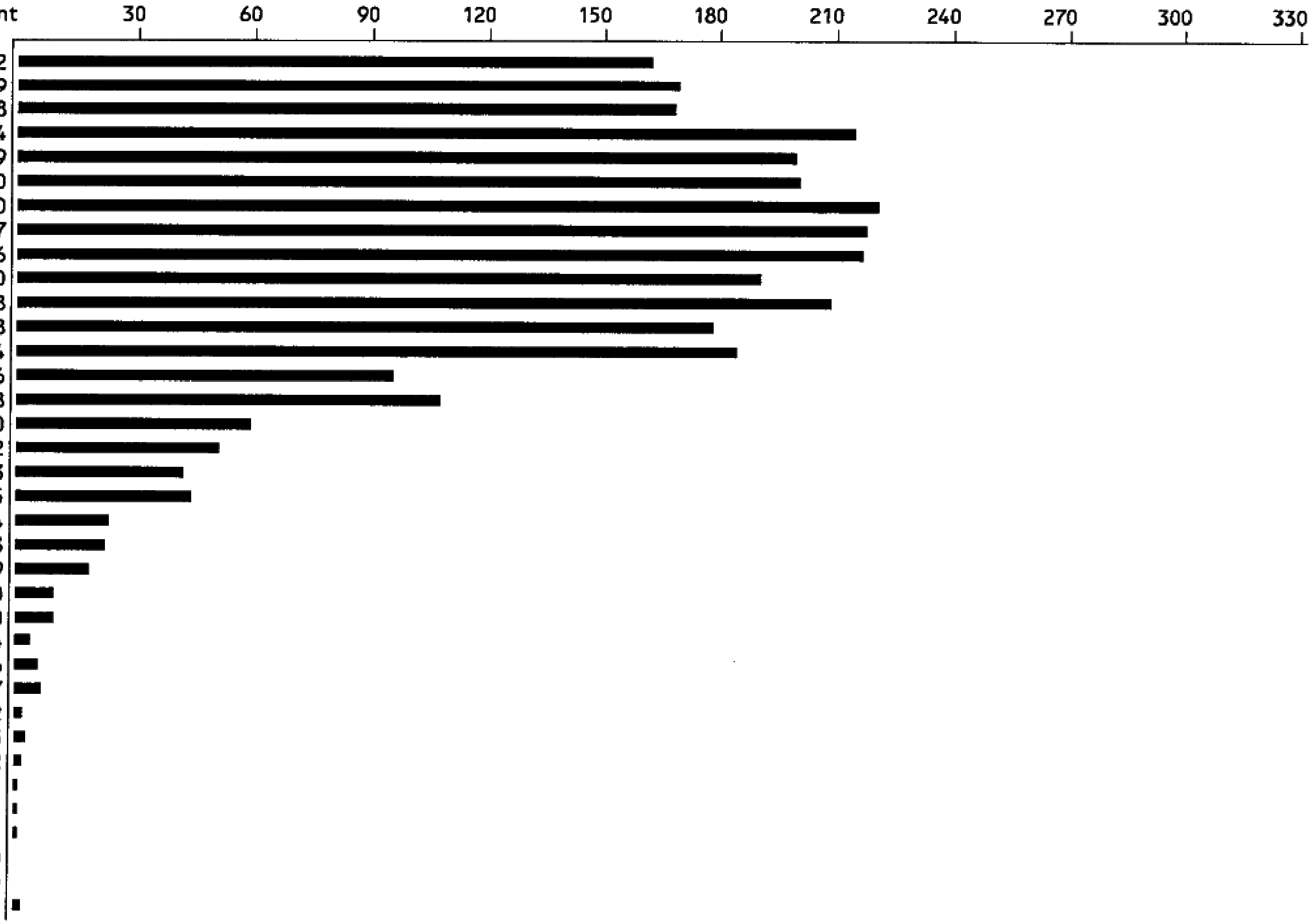


Frequency
Amplitude

Curve Histogram

Date	: 13Feb07		Diam	=	27.3[6.6] u
Sample ID	: ALPACA		Curve	=	66.8[43] deg/mm
Description	: 232		Sample size	=	5509
Lot/Client	: ALPACA FARMS		Curve size	=	3045

cum.%	curve	count
100.0	0	162
94.7	8	169
89.1	16	168
83.6	24	214
76.6	32	199
70.0	40	200
63.5	48	220
56.3	56	217
49.1	64	216
42.0	72	190
35.8	80	208
29.0	88	178
23.1	96	184
17.1	104	96
13.9	112	108
10.4	120	60
8.4	128	52
6.7	136	43
5.3	144	45
3.8	152	24
3.0	160	23
2.3	168	19
1.6	176	10
1.3	184	10
1.0	192	4
0.9	200	6
0.7	208	7
0.4	216	2
0.4	224	3
0.3	232	2
0.2	240	1
0.2	248	1
0.1	256	1
0.1	264	0
0.1	272	0
0.1	280	2



Fiber crimp

- **Fiber crimp (visual or measured as average fiber curvature, AFC) is not an accurate indicator of average fiber diameter.**

Curvature ranges

- Low: < 50 deg/mm, crossbred wool, mohair (~2 crimps per inch). Alpaca 15-55 deg/mm.
- Medium: 60-90 deg/mm, 21 micron Merino and Rambouillet wool (~4 crimps per inch)
- High: >100 deg/mm, 16-18 micron superfine Merino and Rambouillet wool (~7 crimps per inch)

Spinning fineness

- Used by textile processors, a better indicator of processing performance than MFD alone, particularly in spinning.

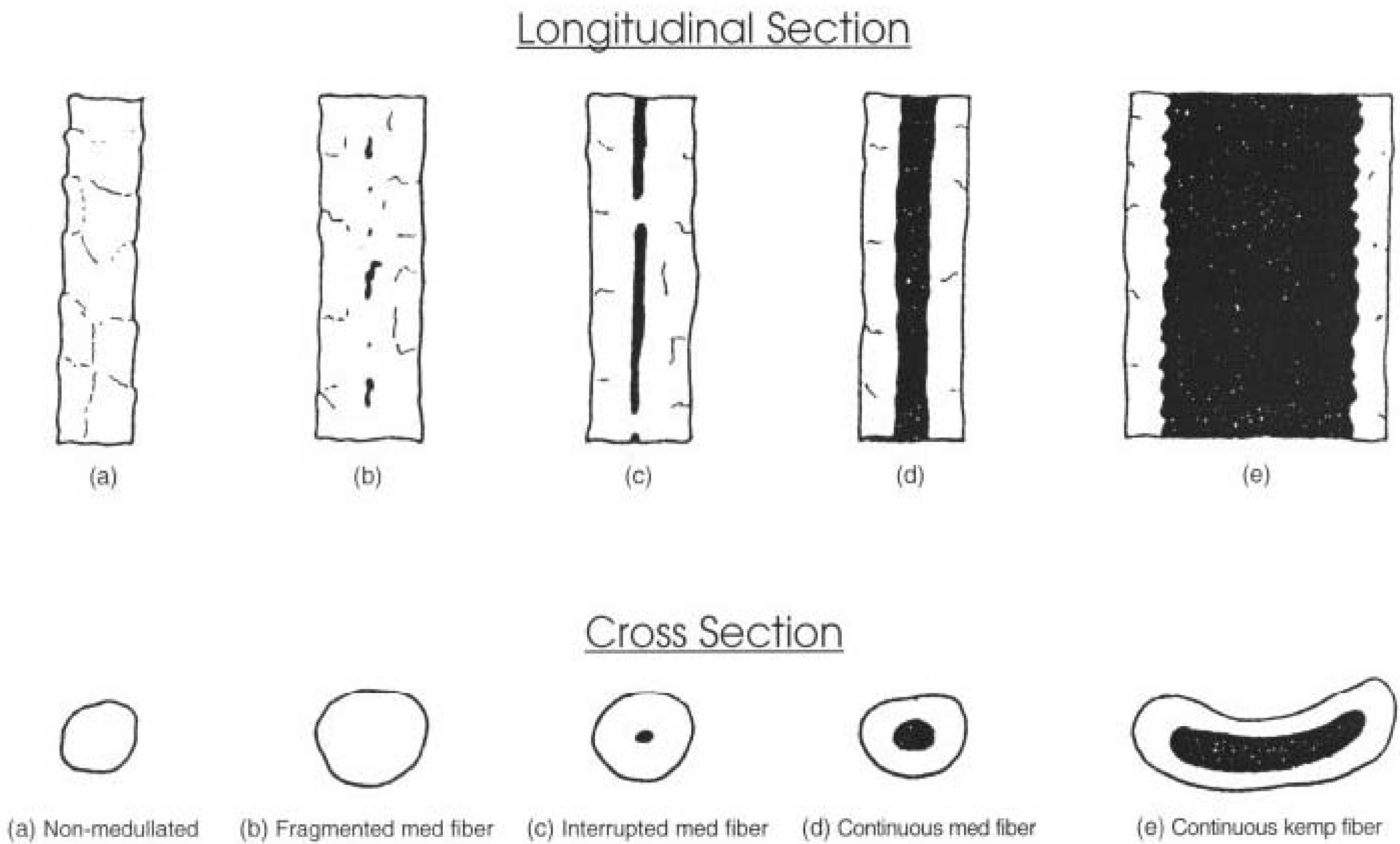
- $SF=0.881*MFD*(1+5*[CVD\%/100]^2)^{1/2}$

- For a given MFD, spinnability ↑ as CV ↓

Coarse Edge Micron (CEM)

- The number of microns above the MFD that contains the coarsest 5% of fibers
- Another statistic used by textile processors
- Smaller = more uniform

Degrees of medullation
(ASTM nomenclature, med, kemp, medullated fiber)



Microprojection

Dark and medullated fibers and contaminants (especially polypropylene) in white fleeces

OFDA 100 - Opacity

Medullation
(IWTO [OFDA100] nomenclature)

- **Total medullated fibers**
- **Flat fibers**
- **Objectionable fibers**
- **Units: per 10,000 or %**
- **AFD, SD of medullated fibers**
- **White and pastel fibers only**

Texas Agricultural Experiment Station

Date : 18Nov04
Sample ID : 024L
Description : S
Lot/Client : TAMU
Operator : FP
5% of fibres 10.6 u above mean.

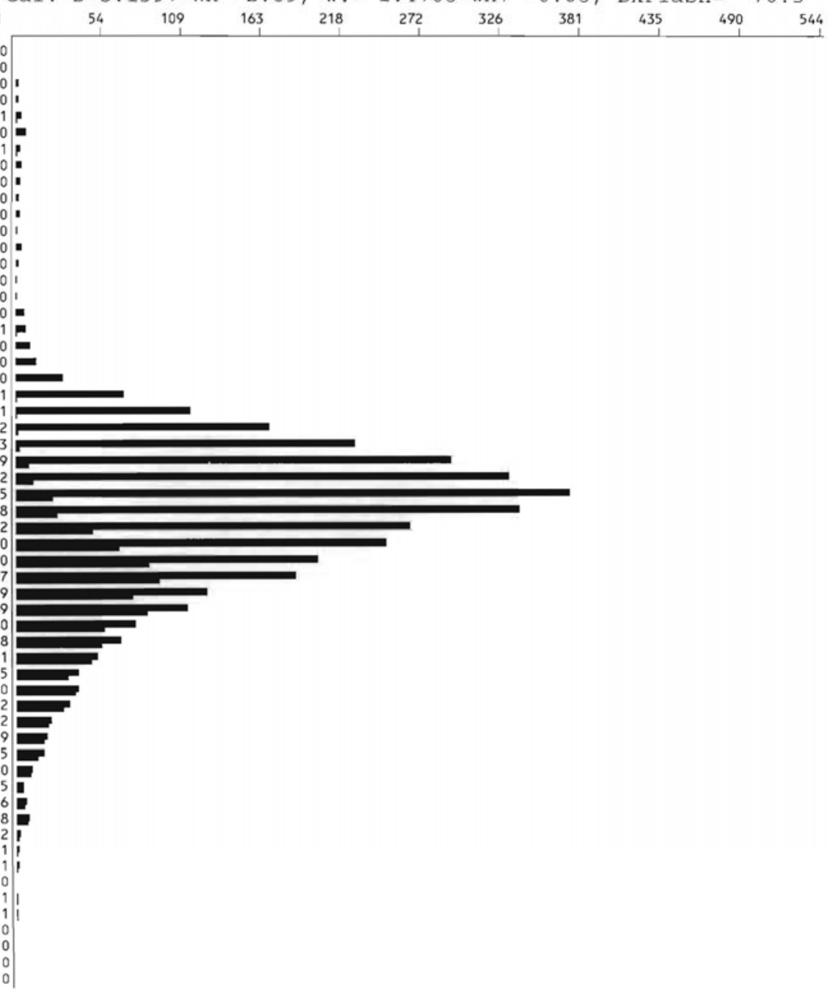
Mean = 29.50 u
SD = 5.64 u
CV = 19.1 %
Sample size = 3627
Spin fineness= 28.3 u
Comfort factor= 63.6 %

Num med= 929(2561/10K)inc 0flat,482obj/10K Mean opacity= 66.6[16.1] %
Mean med diam= 35.0[5.4] u % med by vol= 35.7%, by wt= 23.8%
Op num/10K>= 80 82..100: 2561 2396 2225 1980 1668 1337 943 496 229 110 72

Obj/10K=	>0	>50	>100	>150	>200um	Flat/10K=	>0	>50	>100	>150	>200um
	482	6	3	0	0		0	0	0	0	0

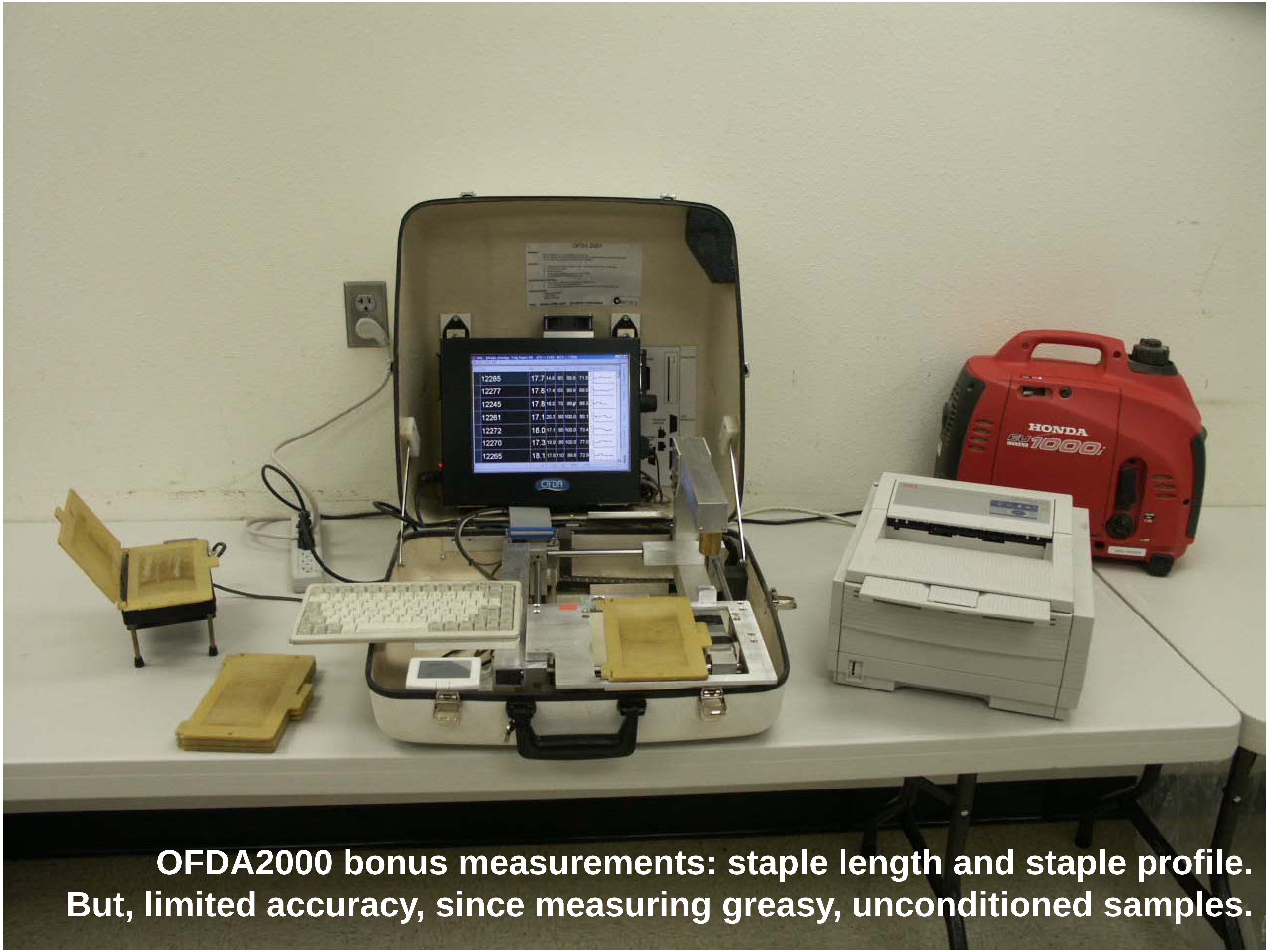
Curve= 32.9[23] deg/mm Curve number = 2397
Along: num= 2435 Mn= 29.5[5.2] Sd= 0.56[0.6] Min= 28.6[5.2] blob= 0.90[0.8]% Sml= 0.60[0.3]% Lge= 0.29[0.7]%
OFDA030:2.12 Cal: D=5.1397*WH -2.69, wV= 1.4708*wH+ -0.08, DkFlash= 70.5

cum.%	mic	count/	med
100.0	1	0/	0
100.0	2	0/	0
100.0	3	2/	0
99.9	4	2/	0
99.9	5	4/	1
99.8	6	7/	0
99.6	7	3/	1
99.5	8	4/	0
99.4	9	3/	0
99.3	10	2/	0
99.3	11	3/	0
99.2	12	1/	0
99.1	13	4/	0
99.0	14	2/	0
99.0	15	1/	0
99.0	16	1/	0
98.9	17	6/	0
98.8	18	7/	1
98.6	19	10/	0
98.3	20	14/	0
97.9	21	32/	0
97.0	22	73/	1
95.0	23	118/	1
91.8	24	171/	2
87.0	25	229/	3
80.7	26	294/	9
72.6	27	333/	12
63.4	28	374/	25
53.1	29	340/	28
43.8	30	266/	52
36.4	31	250/	70
29.5	32	204/	90
23.9	33	189/	97
18.7	34	129/	79
15.1	35	116/	89
11.9	36	81/	60
9.7	37	71/	58
7.7	38	55/	51
6.2	39	42/	35
5.1	40	42/	40
3.9	41	36/	32
2.9	42	24/	22
2.3	43	21/	19
1.7	44	19/	15
1.2	45	11/	10
0.9	46	5/	5
0.7	47	7/	6
0.5	48	9/	8
0.3	49	3/	2
0.2	50	2/	1
0.1	51	2/	1
0.1	52	0/	0
0.1	53	1/	1
0.1	54	1/	1
0.0	55	0/	0
0.0	56	0/	0
0.0	57	0/	0
0.0	58	0/	0



0.5	63	1/	1
0.5	64	6/	6
0.3	65	2/	2
0.3	66	1/	1
0.2	67	1/	1
0.2	68	2/	2
0.2	69	0/	0
0.2	70	2/	2
0.1	71	1/	1
0.1	72	0/	0
0.1	73	1/	1
0.1	74	1/	1
0.1	75	0/	0
0.1	76	0/	0
0.1	77	1/	0
0.0	78	0/	0
0.0	79	0/	0
0.0	80	0/	0
0.0	81	0/	0
0.0	82	0/	0
0.0	83	0/	0
0.0	84	0/	0
0.0	85	0/	0
0.0	86	0/	0
0.0	87	0/	0
0.0	88	0/	0
0.0	89	0/	0
0.0	90	0/	0
0.0	91	0/	0
0.0	92	0/	0
0.0	93	0/	0
0.0	94	0/	0
0.0	95	0/	0
0.0	96	0/	0
0.0	97	0/	0
0.0	98	0/	0
0.0	99	0/	0
0.0	100	0/	0
0.0	101	0/	0
0.0	102	0/	0
0.0	103	0/	0
0.0	104	0/	0
0.0	105	0/	0
0.0	106	1/	1
0.0	107	0/	0
0.0	108	0/	0
0.0	109	0/	0
0.0	110	1/	1

µm   Number of fibers



OFDA2000 bonus measurements: staple length and staple profile.
But, limited accuracy, since measuring greasy, unconditioned samples.

Staple Profile (OFDA2000 only)

- Fiber diameter measured along the staple
- Left side tip, right side base of staple
- Can see how MFD changes during the growing season.

Figure 7. Histogram and typical staple profile for an alpaca

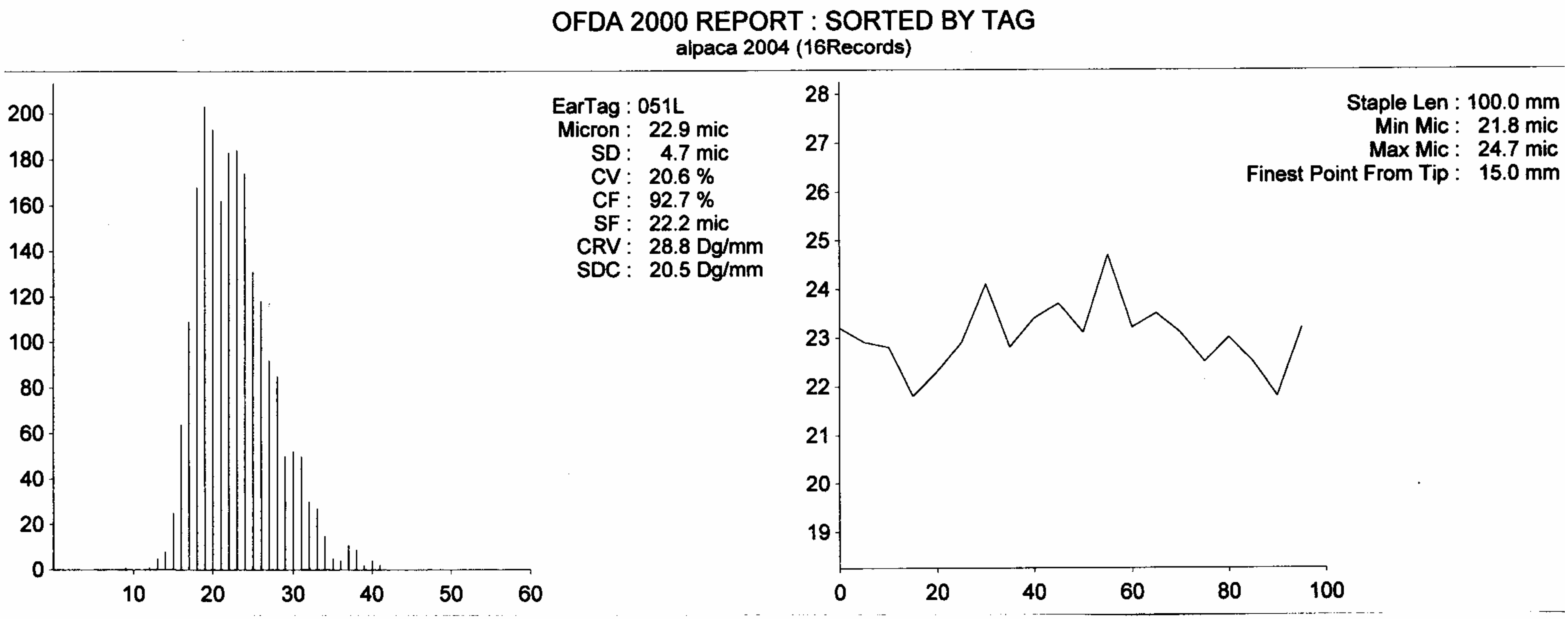
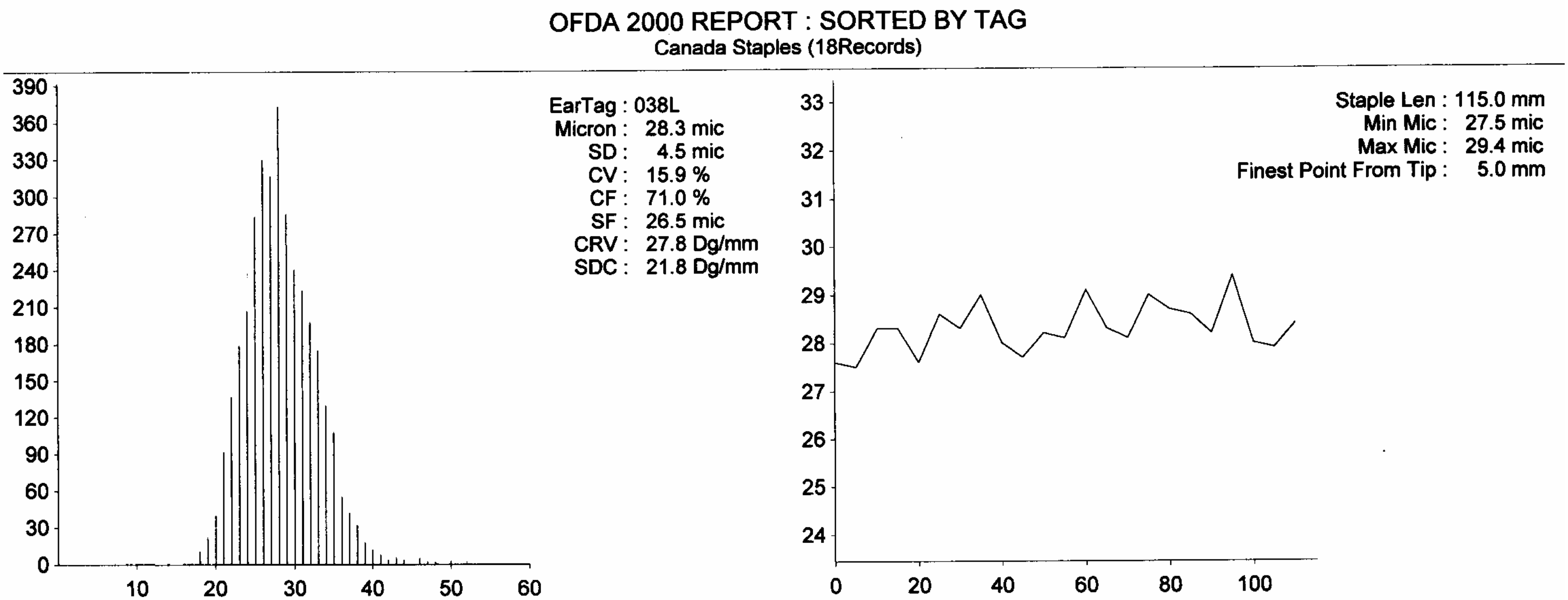


Figure 8. Histogram and typical staple profile for very uniform alpaca



Staple profile (contd.)

FPFT – Finest Point From Tip

Used to indicate where the MFD is the smallest and most likely to break during processing

MFE – Mean Fiber Ends

MFD at the ends of the staple

Relationship to comfort factor?

Minimum and Maximum MFD along staple

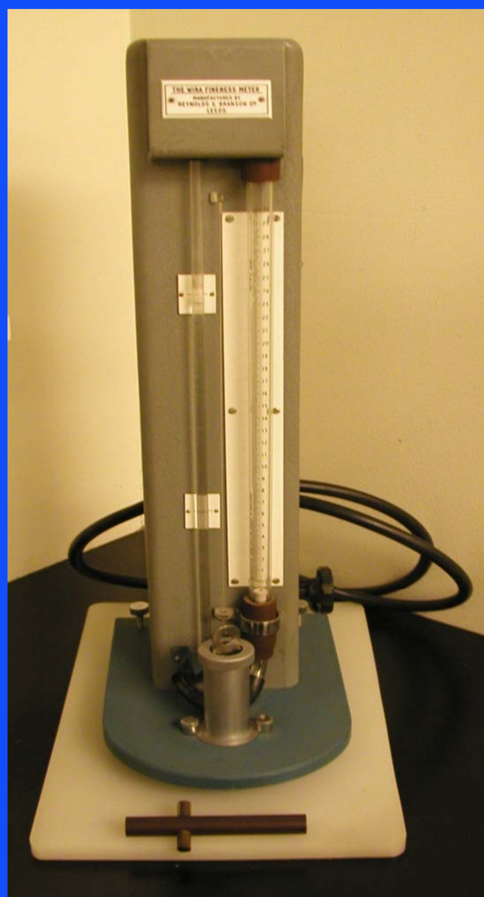
Excellent for selection purposes

% fibers < 15 microns

Staple profile (contd.)

- Drastic changes in diameter can cause a weakness in the staple strength and can impact processing ability (breaks).
- Use the information to make management decisions to grow sound fiber
  - Shearing in relationship to parturition, lactation, etc.
  - Supplemental feeding strategies

Airflow (WIRA)



- Measures flow of air through fiber sample.
- Indirect measurement of AFD.
- Does not measure

  SD, CV, curvature, or medullation.
- Very few, if any, calibrated for alpaca.
- Medullation affects accuracy of measurement.

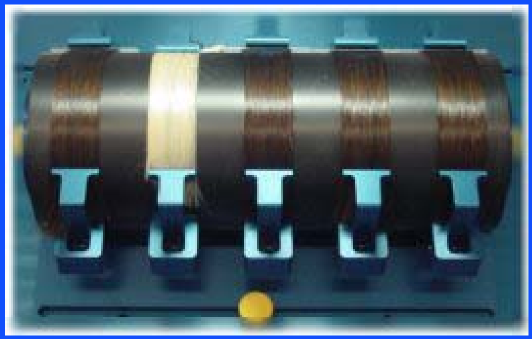
Resistance to Compression

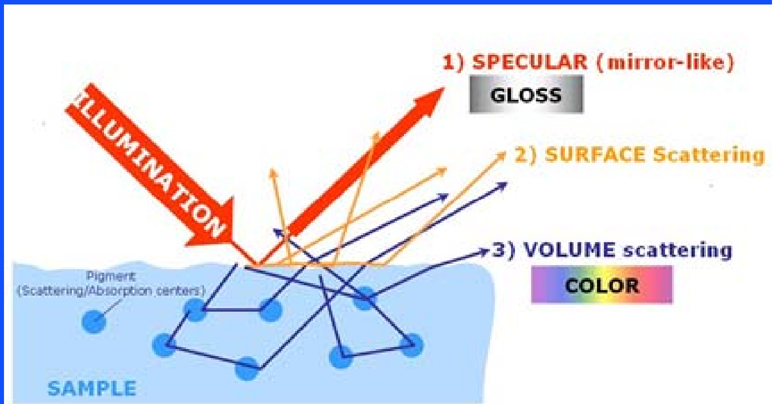
Colorimeter

Tristimulus values
Whiteness
Yellowness
Brightness

Luster

- Goniophotometer. Single fibers, slow, expensive.
- Opacity (OFDA 100) and NIRS.
- SAMBA Hair System. Very promising.



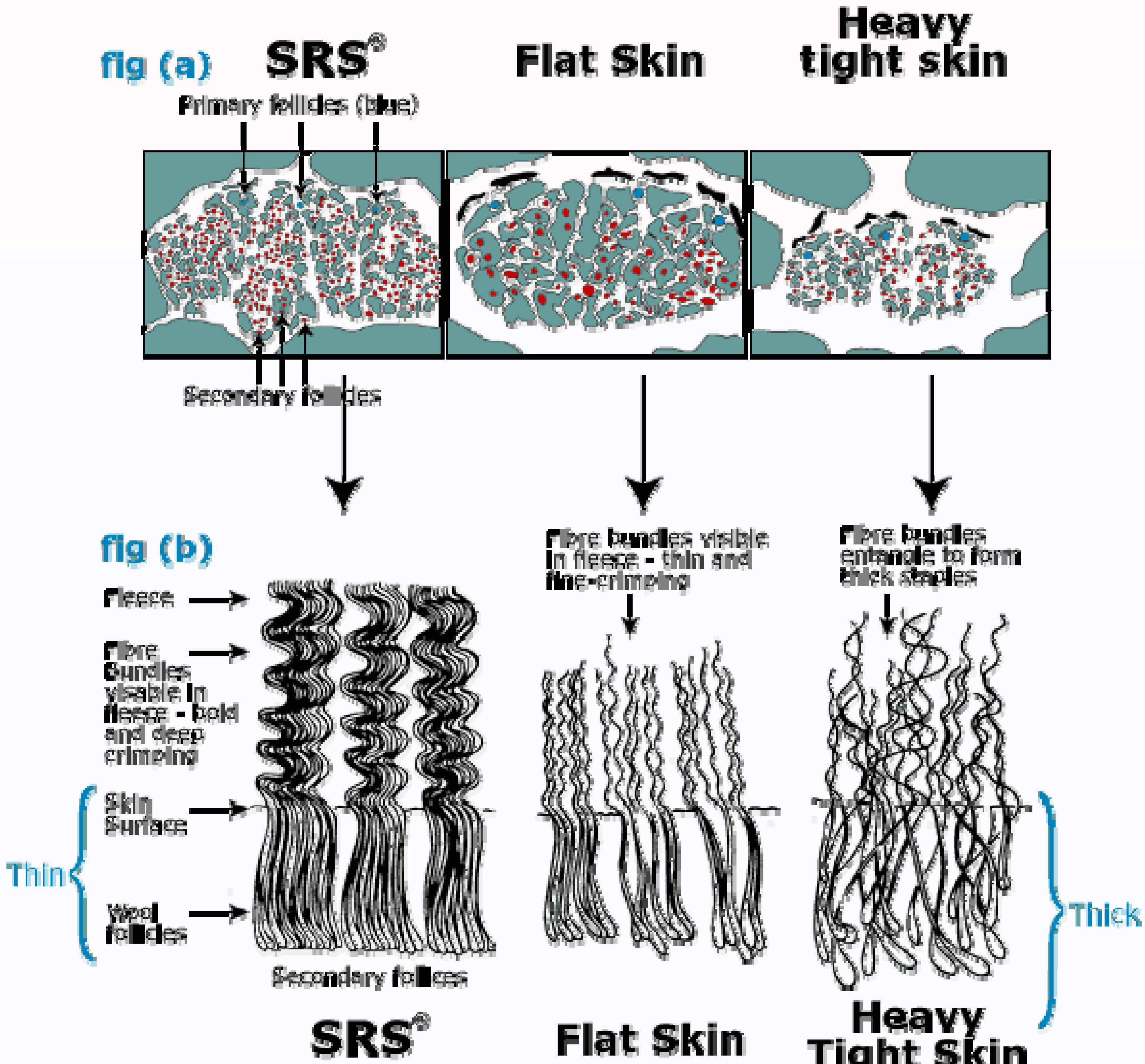


Of great interest to breeders (but not the textile industry)

- Body weight
- Fleece weight
- Fiber density (fibers per unit area of skin)

Fibers per unit area

- Traditionally determined using histological / staining methods. Not particularly accurate and requires removal of multiple skin samples using a trephane.
- However, skin sections capable of revealing additional information.



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Fibers per unit area

- Alternatively, and less invasively, a known area can be shorn from the mid-side.
- Knowing staple length, clean weight, average fiber diameter, and density of alpaca fibers, can calculate fibers/unit area.

Accuracy of objective measurements

- Don’t get carried away with the second number after the decimal place!!

95% confidence limits

- Fiber base (clean yield): 1 to 2%
- VM Base: 0.1 to 2%
- MFD: 0.2 (15 micron) to 0.9 (40 micron)
- Staple length: 5 mm
- Staple strength: 6 N/ktex

IV. Genetic Evaluation of Fiber Traits in Alpaca

Genetic improvement of alpaca

Is usually geared towards:

- Increased production (per animal or per unit of BW).
- Increased production (per unit of land base).
- Improved quality (decreased fiber diameter and medullation, for example, so that a unit amount of fiber is worth more).

Genetic improvement of fiber production

- Conventional

- Define breeding objectives
- Select measurable, heritable trait(s) that exhibits variation among individual animals.
- Apply maximum selection pressure (mainly from male side).
- Reduce generation interval

Genetics Theory (Simplified)

$$\text{Genetic improvement per year} = \frac{\text{Heritability } (h^2) \times \text{Selection differential}}{\text{Generation interval}}$$

Genetic tools available in the U.S. for improvement of fiber production

- **A National Alpaca Improvement Program,** The Ideal Alpaca Community, Mike Safley (OR) and Dave Notter (VA).
- **Genetic Alpaca Improvement Network (GAIN),** Wayne Jarvis, Holley, New York.

The most active program for genetic evaluation of U.S. sheep is:

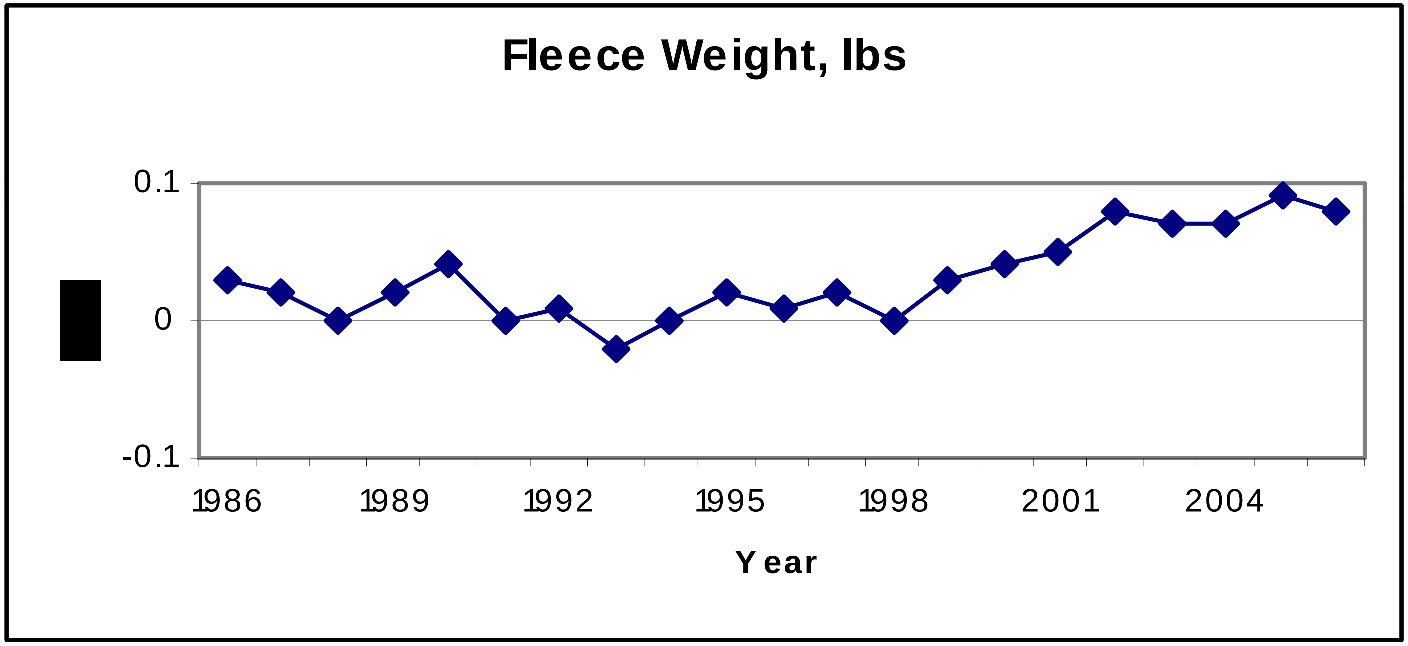
- National Sheep Improvement Program.
  - ASI Program
  - Genetic Evaluation Center at Virginia Tech

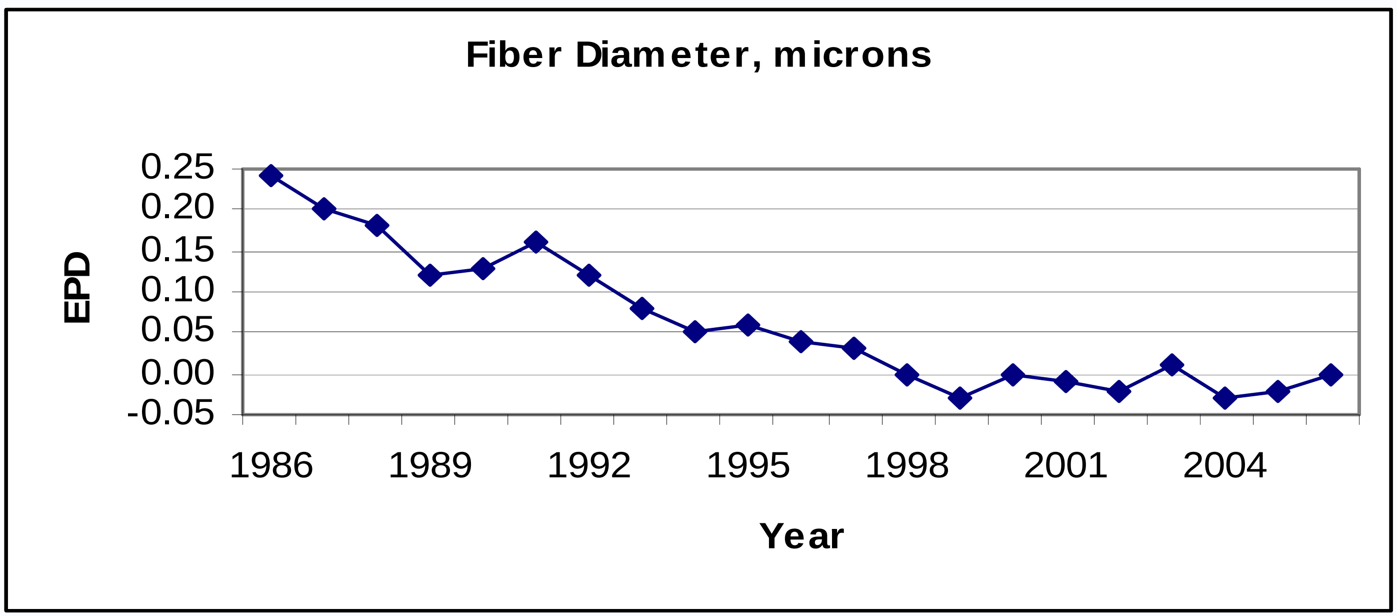
NSIP Clients

- Targhee (TA) Suffolk (SU)
- Polypay (PP) Katahdin (KT)
- Dorset (DO) Columbia (CL)
- Hampshire(HA) Boer Goat (BO)
- Romney group (Romney, Dorper, White Dorper, Coopworth)
- Texas Rambouillet Nucleus Flock

- In 2008
- Kiko Goat (KI)
- Ideal Alpaca Community

Genetic Trends in Targhee Sheep





Genetic tools for improvement of fiber production

- **Estimated breeding values, EBV (or estimated progeny difference, EPD)**
- **An EBV can be calculated for each measurable trait of an individual animal.**
- **The trait is adjusted for DOB, sex, BW, type of birth, etc. and expressed as a deviation from the mean for contemporary animals.**

Genetic tools for improvement of fiber production

- Estimated breeding values, EBV (or estimated progeny difference, EPD)
- EBV is calculated as a function of the adjusted trait deviation, heritability of the trait, correlation between measured traits, and records of relatives.
- Within- and across-flock EBV’s are calculated (the latter when sufficient genetic connections are present among flocks).

Genetics Theory (Simplified)

To design an effective alpaca breeding program and to be able to accurately predict progress, we must have:

- Accurate estimates of **heritability**, **genetic and phenotypic correlations** among traits, and **phenotypic variation** within traits.
- It is also important to have **relative economic values** for each trait (preferably long-term averages unless specific knowledge is available on what the future holds).

Heritability values

- $h^2 > 0.40$, high
- $h^2 = 0.20\text{-}0.40$, moderate
- $h^2 < 0.20$, low

Most alpaca fiber traits are moderate to highly heritable.

Heritability estimates for alpacas (Chavez, 1991; Ponzoni et al., 1999; and Wuliji et al., 2000)

Trait	h^2
Grease fleece weight	0.21 - 0.83
Clean yield	0.37 - 0.67
Clean fleece weight	0.68 - 0.79
Mean fiber diameter	0.67 - 0.73
CV fiber diameter	0.90
Mean staple length	0.43 - 0.63
Live weight	0.27 - 0.69
Staple strength	0.16
Resistance to compression	0.69

Genetic Improvement of Alpacas

If concurrent selection for more than one trait is desired then several approaches may be considered.

1. **Index selection** in which each trait is weighted by its heritability and economic value.
2. **Independent culling levels.** Threshold level for each trait.
3. **Combination** of 1 and 2.

Genetic correlations

- **Favorable – Fleece weight and staple length.**
- **Neutral – Clean yield and staple length; fiber diameter and staple length.**
- **Antagonistic – Fleece weight and fiber diameter.**

Molecular biology for alpaca improvement

- The tools are likely to prove very useful for:

❖ Identifying traits in young animals that cannot normally be measured until the animal matures e.g., a cria's genetic potential to remain fine.

❖ Detecting carriers of deleterious physical defects in animals that do not themselves exhibit the problem (e.g., Spider lambs).

Molecular biology for alpaca improvement

- The tools could prove very useful for:

- Identifying animals with resistance to internal and external parasites, or potential for improved growth, for example.
- Other traits that are difficult to measure directly.

Molecular biology for alpaca improvement

- The tools have already proven to be very useful in other species for identifying:

- Beef cattle bulls whose offspring will produce more tender meat.
- Dairy cattle bulls whose offspring will produce more milk.
- To name just a couple.

Molecular biology for alpaca improvement

- But, as an animal fiber metrologist, I feel obliged to point out to breeders that if a fiber trait is measurable, highly heritable, and economically important, then keep measuring it.
- The fiber test is likely to be much less expensive than the DNA test.

Questions?