

## N-CSA Color & Pattern Terms and Definitions

This document provides definitions for each of the traits listed as selection options for “Color and Pattern” in the new N-CSA registration database. Traits are organized according to the genetic location (or *locus*) of the information within the sheep. Each locus has many genes called *alleles*. Each lamb has pairs of *alleles* (one from each parent) that determine its color and pattern, as well as all other aspects of its physical makeup.

### **Base Color: The Black/Brown Locus**

*Eumelanin* pigments produce black or brown color in sheep at the *Black/Brown (B)* locus. The color black is dominant to brown. If both parents pass on an allele for black, the sheep will have black as its base color. If only one parent passes on an allele for black, the sheep will also have black as its base color. If both parents pass on the allele for brown, the sheep will have brown as its base color.

The *B* locus is symbolized by an uppercase “*B*” followed by the scientific shorthand for black (+) or brown (*b*). The “+” symbol is used for the most common variant of an allele. Every sheep will have two alleles at the *B* locus (for example, *B+B+* = a black sheep).

**Black (*B+*)**—A black sheep may have some or all of the following attributes: black fibers in the fleece or hairy points, black coloring in the hooves, horns, nose, and soft tissues.

**Brown (*Bb*)**—A brown sheep may have some or all of the following attributes: brown fibers in the fleece or hairy points, brown coloring in the hooves, horns, nose, and soft tissues.

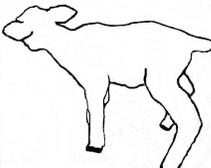
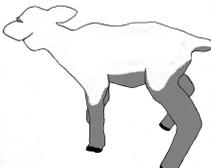
### **Pattern: The Agouti Locus**

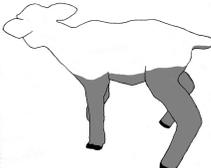
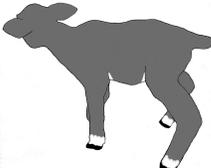
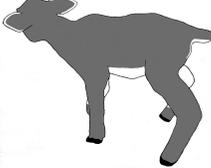
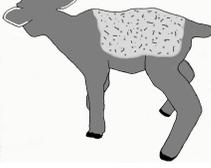
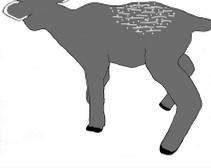
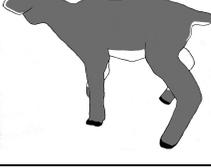
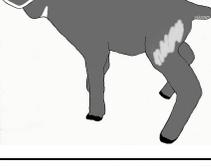
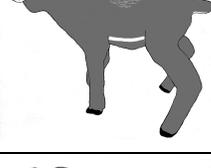
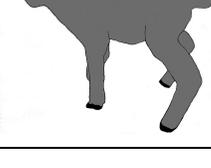
The *Agouti* locus is a modifier of the *B* locus. The *Agouti* locus is responsible for determining whether a mammal’s coat is banded with white/tan fibers in a bilateral pattern (*Agouti*) or is solid (*self-color*). Every sheep will have two alleles for pattern at the *Agouti* locus (one from each parent). Note any of the patterns, including *white/tan (Awt)*, can appear on a black or brown-based sheep.

Patterns with a large amount of white/tan tend to “dominate” the expression of darker patterns. *white/tan (Awt)* is the lightest pattern and is considered most dominant. *self-color (Aa)* is the darkest pattern and is considered most recessive.

Intermediate patterns are “co-dominant.” If a lamb receives two different pattern alleles the pattern with more white will probably be more visible, especially at birth. In some cases the two patterns will “co-express,” meaning both patterns are visible. Patterns listed below are in a hierarchy of “dominance” determined by the amount of white/tan in the display.

The *Agouti* locus is symbolized by an uppercase “*A*” with the pattern name’s scientific shorthand in lowercase letters. Line drawings are copyrighted by Dee Heinrich and featured in *The Coat of Many Colors* by Margaret Howard. The book can be purchased online at <http://www.tawandafarms.com>.

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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <p><b>white/tan (<i>Awt</i>)</b>—This pattern may appear with random tan spotting, tan body, and/or tan face and legs. Tan is caused by <i>phaeomelanin</i> pigments which include shades of red, yellow, apricot, orange, ginger, brown, and gray. This coloring generally disappears by the first shearing. Kemp fibers when present are tan.</p>                   |  |
| <p><b>light badgerface (<i>Albf</i>)</b>— White/tan body with dark belly. Similar to <i>badgerface (Ab)</i> with more white/tan frosting. Body/belly separation less defined. Look for frosting in the inner ear, throat, armpit, belly, scrotum, sides of tail/anus. Dark eye bar may extend from tear duct up to horn base. May have small white/tan moustache.</p> |  |

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| <p><b>badgerface (Ab)</b>–White/tan body with dark belly. Defined body/belly separation to tail tip. Dark eye bar with white/tan “shadow” above eye, dark patch under eye. Dark inner ear, dark muzzle, dark along jaw extending down throat to belly. Tan spots or patches may look like brown spots on the body. Tan spots are <i>phaeomelanin</i> and tend to fade or disappear by the first shearing.</p>                        |    |
| <p><b>gray (Ag)</b>–Lambs born black or dark gray with wool changing rapidly to light gray or almost white by weaning (with dark tips). White/tan in front and rear flanks can be seen from the side, front flanks connected with white across or just above brisket. May have white ring around hooves. Frosted inner ear with dark rim. Frosted muzzle, chin, moustache and/or a white triangle from upper lip to nose bridge.</p> |    |
| <p><b>gray &amp; tan (Agt)</b>–Similar to <i>black &amp; tan (At)</i> but the sheep is gray in areas where the <i>black &amp; tan (At)</i> sheep is dark (black or brown).</p>                                                                                                                                                                                                                                                       |    |
| <p><b>blue (Abi)</b>–Dark lamb with white/tan moustache or nose bar/ring extending up to tear ducts and forehead. White/tan teardrops low and off-the-duct. Dark nose. Rimmed ears. Frosted saddle area extending past shoulder and shy of tail head.</p>                                                                                                                                                                            |    |
| <p><b>english blue (Aeb)</b>–Very dark body. White display includes light saddle area, small at-the-duct teardrops, ear rimming, and small moustache sometimes extending up cheeks. May show a central ear spot.</p>                                                                                                                                                                                                                 |   |
| <p><b>black (or brown) &amp; tan (At)</b>–Opposite body/belly markings to <i>badgerface (Ab)</i>, dark body with white/tan belly. Defined body/belly separation to tail tip. Legs dark outside, white/tan inside. Frosted inner ear with dark rim, may have short white/tan eye bar, small moustache, light chin. Also occurs in brown-based sheep, known as <i>brown &amp; tan (also At)</i>.</p>                                   |  |
| <p><b>swiss markings (Asm)</b>– Dark lamb with white bars ascending from moustache past tear ducts to connect with ear. Ears rimmed white, inner ear frosted except tips. White neck kerchief ends behind ears. Dark body, frosting on belly. Possible light area at top of rear leg or hip.</p>                                                                                                                                     |  |
| <p><b>lateral stripe (Als)</b>–Very dark body/belly with defined white stripes along belly from elbow to knee. Stripes are white the full length from skin to tip of fibers. White chin, white moustache may sweep up dramatically. Tight at-the-duct teardrops. Dark ears with pronounced white inner ear rimming and some outer ear rimming.</p>                                                                                   |  |
| <p><b>self-color (Aa)</b>–This is the most recessive pattern. It presents as a completely dark sheep, either black or brown, from <u>two Agouti-patterned parents</u>. White spotting may still occur.</p>                                                                                                                                                                                                                           |  |

## **Spotting: The S Locus**

Spots are irregular areas of true white (not tan) appearing on a black or brown sheep. Unlike the white/tan banding of the *Agouti* locus, *Spotting* is random and asymmetrical. It often shows up first on the midline (head, tail, anus, bottom of the legs). Extensive spotting may partially or entirely obscure underlying *Agouti* patterns, especially as the sheep matures.

The *Spotting* locus is symbolized by an uppercase “S.” “No spotting” (S+) is a dominant gene and “spotting” (Ss) is a recessive gene at the S locus.

Common examples of the effect of the S locus in our breed include:

**Blaze**–White extending up the bridge of the nose to the forehead.

**Cap**–White on top of the head.

**Anklets**–White ring encircling the ankle.

**Socks**–White from the hoof to above the ankle.

**Tail tip**–White on the tip of the tail.

**Pinto**–Looks like large patches of color on the body, may involve the head area.

**Ticking**–Looks like freckle-like patches of color on the body.

**Random**–Irregular areas of white appearing anywhere on the sheep. Can make pattern identification tricky without birth photos.

Spotting is indicated in the horn and hoof by the *absence* of dark color. Horns/hooves may be light-colored or striped. One can also look for the absence of color in the nose and lips which may appear pink instead of black or brown. This is common in the *white/tan* (Awt) pattern where the S locus may suppress all color including tan.

## **Dominant Color: The Extension Locus**

There are two reasons why Navajo-Churro sheep can appear solid black or brown. One is due to the *self-color* (Aa) allele at the *Agouti* locus and the other is due to a dominant color gene from either parent at the *Extension* locus. Most sheep breeds (and many of our Navajo-Churro sheep) receive the “wild” gene from both parents at *Extension* (E+E+) which allows full expression of patterns at the *Agouti* locus. The *Extension dominant* (Ed) allele from one or both parents overrides patterns at the *Agouti* locus and results in a solid black or brown sheep. Note that white spotting (such as cap or socks) may still appear.

Due to their solid coloring an *Ed* sheep is easily confused with a *self-color* (Aa) sheep. A determination about *Ed* or *Aa* is made through progeny testing. *Ed* sheep will only produce solid offspring. *Aa* sheep will produce offspring with patterns.

## **Other Possible Traits**

We are using this category in the database to gather information about important “types” within the Navajo-Churro breed. They are driven by unproven (but suspected) alleles or other modifiers we need to identify.

**Blue Dilute**–Also known as *NSP Blue*. Born black but in the first year develops silver/charcoal inner coat while outer coat remains brownish/black. May have cap, small blaze or other white spotting, but will keep dark points and legs. Resembles *gray* (Ag) but does not have sugaring of lips or points. First year fleece has tips and fibers are gray to the roots (not a mix of black and white). The mature sheep retains a “blue gray” fleece on body/belly that may lighten with age. Often a bronze/metallic sheen to face, ears, and legs. No white tear drops.

**Brown Dilute**–Similar to *Blue Dilute* but on a brown-based sheep.

**Dark Brown**–Also called *Rio Grande* wool color. *Dark Brown* sheep are born nearly black and the wool remains a dark color between black and moorit brown. At a year fleece remains dark chocolate brown which may lighten with age. There may be minor spotting and perhaps reddish brown oxidizing of the tips (that also occurs in black sheep). The dark brown wool is more obvious when compared side-by-side to black wool.

**Churra markings**–A white sheep with clustered dark marks or large dark patches around the eyes and mouth/muzzle. May also have a dark inner ear. The visible dark (black or brown) is the base color of the sheep. “Churra marked” sheep will continue to be registered as *white/tan* (Awt) although it is unclear in the scientific community whether Churra markings are a “pattern” driven by the *Agouti* locus, spotting due to the S locus, or some other genetic mechanism.

**Brockle-face/legs** –Freckling or “dappling” of face and legs on a white sheep. The visible dark (black or brown) is the base color of the sheep. “Brockle-face” sheep will continue to be registered as *white/tan (Awt)*. As with Churra markings, it is unclear exactly which allele drives the appearance of “brockle-face.”

We welcome your feedback and questions regarding this document. Please feel free to contact Connie Taylor [churrosheep@me.com](mailto:churrosheep@me.com) or Ingrid Painter [puddleduck@proaxis.com](mailto:puddleduck@proaxis.com). If there are patterns or traits in your sheep that you don't see reflected in this work we would be thrilled to hear from you.

## **References**

*Timeless Coloured Sheep* by Michael Imhof Verlag and edited by Dawie Du Toit, copyright 2014.

*The World of Coloured Sheep* compiled and edited by Roger S. Lundie and Elspeth J. Wilkinson, copyright 2004.

*The Coat of Many Colors* by Margaret Howard and edited by Dee Heinrich, copyright 2012.

*I Am A Shepherd* by Margaret Howard, copyright 2016.

“The BASE of Color in Sheep” by Dee Heinrich, Black Sheep Newsletter, Summer 2017.

“Color inheritance in Icelandic sheep and relation between colour, fertility, and fertilization” by Stefan Adalsteinsson, PhD., *Journal of Agricultural Research in Iceland* Volume 2,1, published by Ag Research Institute, Reykjavik, Iceland, 1970.

“Guide to the Selection of Navajo-Churro Sheep” by Navajo-Churro Sheep Association, 2010. <http://www.navajo-churrosheep.com/Forms/N-C-FIRSTEDITION.pdf>