A STUDY OF COTTON COLOR DRIFT FROM COTTON BALES STORED FOR MAKING THE USDA UPLAND GRADE STANDARDS

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Abstract

Color drift was studied on data from 307 bales of cotton covering the full range of U.S. Upland cotton color grades. The bales studied were previously part of the inventory of bales warehoused for the purpose of making the annual USDA Upland grade standards. The bales were all U.S. grown Upland cotton from various parts of the country and covered crop years ranging from 2001 through 2015. Bales were acquired soon after ginning and stored in the non-air conditioned USDA Cotton Standards warehouse in Memphis, TN. Rd and +b color measurements were made at initial bale acquisition and repeated once per year thereafter until the bales were exhausted for making standards or until the bales were sold back to the cotton industry as a result of no longer having potential standards' use. Increases in color +b were observed across bales of all color grades with the largest increases found in the high white grade bales. The low white grade bales and low spotted grade bales had the lowest degree of +b increases. Relatively large color Rd decreases were observed in the good-middling white grade with declining decreases in Rd moving from the high white grades to the low. Insignificant Rd changes were mostly observed for bales in the middling and strict-low-middling grades with moderate increases in Rd in low white grade bales. For the spotted and tinged grade bales, substantial +b increases were found in the strict-middling spotted grade and tinged grades. Rd changes in the spotted and tinged grade bales had mixed results showing some grades with small increases and others with small decreases.

Introduction

Color Rd and color +b are the basic instrument color measurements used in cotton classification. Taking the two measurements together, an Upland cotton's color grade is determined from the USDA color diagram (Figure 1).

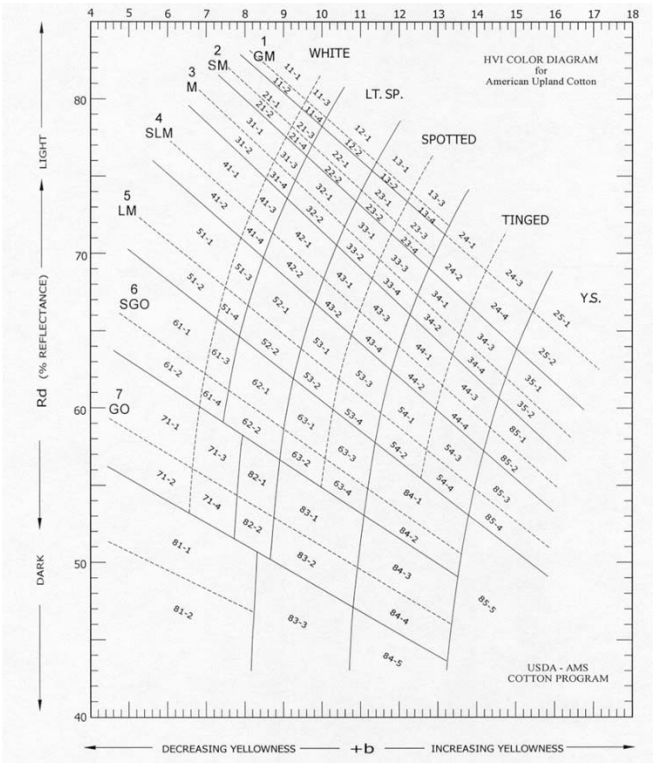

Figure 1. USDA Upland Color Grade Conversion Diagram.

Although it is accepted that the color of cotton changes over time, the amount and rate of change varies from cotton to cotton. Factors including temperature and moisture contribute, but a comprehensive understanding of the color change phenomenon is lacking. In order to contribute to the understanding of color drift in cotton bales, data resulting from USDA's annual production of the U.S. Upland grade standards was analyzed and is presented in this paper.

USDA's Upland grade standards' boxes have been produced annually for over 100 years. Today, approximately 1,500 boxes are produced each year and are only valid for one year primarily due to the change in cotton color that occurs with age. Approximately 100-150 bales are purchased from the U.S. crop each year to maintain an adequate inventory for annually producing the full range of the Upland grade standards which are made up of 15 different physical grades covering the range of U.S. Upland cotton. Bales purchased for this purpose are delivered to the USDA cotton standards warehouse where they are stored until used or sold back to the cotton industry. A rolling inventory of approximately 300 bales is continuously maintained to provide sufficient options when selecting bales for each year's grade standards. Some bales are kept for many years and some may be used or sold within a year.

Warehouse storage of the bales is mostly typical of a warehouse in the Memphis area. The warehouse is not air conditioned, but does have fan ventilation that is activated during hot days in the summer. Some heating is provided in the winter to keep the warehouse temperature from falling below approximately 55-60 degrees Fahrenheit.

The process outlined above for producing the annual grade standards provides a unique opportunity for evaluating cotton color drift without the expense of conducting an expensive study. Separate from this process, obtaining detailed color measurements on bales over time on a wide cross section of grades, crop years and growing regions would be costly and logistically challenging.

Materials and Methods

For this study, color data were used from 307 bales that were previously part of the grade standards' bale inventory. Bales selected were from across the U.S. Upland cotton growing belt, covered crop years from 2001 through 2015 and had at least two years of storage history. Bales were acquired soon after ginning and immediately sampled and measured for color upon delivery to the USDA's Memphis cotton standards' warehouse. Thereafter, the bales were resampled and re-measured annually in September for as long as the bales were kept. Sampling the bales involved removing the top 4 to 5 bands and removing 12 half-pound samples from across the layers or "fanhead" of the bale. The 12 samples were then prepared into 5 by 7 inch sample biscuits. The 12 biscuits were then measured for Rd and +b on the USDA standards colorimeter. The overall bale color for each bale was determined by averaging the readings from the 12 biscuits together. Tables 1 through 3 give the break-down of the bales by crop year, initial color grade, and growing region, respectively.

Table 1. 307 study bales sorted by crop year.

Crop Year	# of Bales	Crop Year	# of Bales
2001-06	11	2011	38
2007	54	2012	23
2008	26	2013	33
2009	53	2014	9
2010	42	2015	18

Table 2. 307 study bales sorted by initial color grade.

Color Grade	# of Bales	Color Grade	# of Bales	Color Grade	# of Bales
11	58	61	10	53	5
21	61	71	7	63	8
31	38	23	22	34	12
41	30	33	10	44	9
51	20	43	10	54	7

Table 3. 307 study bales sorted by growing region.

Growing Region	# of Bales
Southeast	37
Mid-South	46
Texas	171
Far West	53

Results and Discussion

Figures 2 and 3 give the +b and Rd results, respectively, for the white grades over a three year period. The bars give cumulative results, so for example, the 3-year change bars represent the total color change over a 3-year period. Results in Figure 2 show that the +b change is greatest in the high white grades and decreases with decreasing color grade. For Rd, the high white grades show a decrease in Rd while the low white grades show an increase in Rd. The transition between decreasing Rd and increasing Rd appears to occur around the middling (grade 31) color grade region.

Most color grade Good-middling (grade 11) bales in this study were acquired from California and most color grade Strict-middling (grade 21) bales were purchased from Texas. This gave an opportunity to compare color drift between these two regions on cottons with high color grades. Figures 4 and 5 show the results for three years of bale aging. The results show the average color changes for 13 California grade 11s versus 29 Texas grade 21s. Over the three-year period, the results for both groups of cottons were very similar for +b with a total +b change of around 2.0 +b units. For Rd, the results showed a little more decrease in Rd (-1.4 units) for the California 11s versus the Texas 21s (-1.1 units).

Figures 6 and 7 give the +b and Rd results, respectively, for the spotted and tinged grade bales. The largest +b increases were found in grade 23 and in the tinged grades. In general, with the exception of grade 23, the spotted grades showed modest +b increases. For Rd, all spotted grades showed increases in Rd except for grade 23 which decreased slightly. The tinged grades all decreased in Rd with grade 34 having the largest decrease.

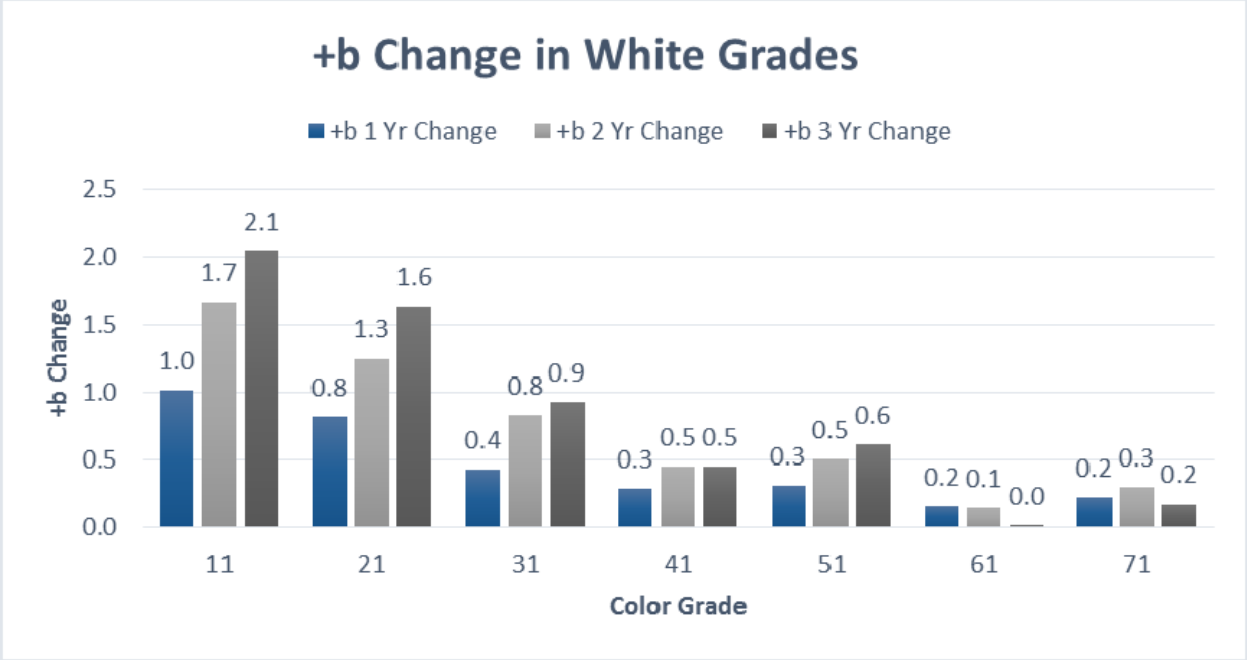

Figure 2. 1, 2, and 3 year changes in +b for white grades.

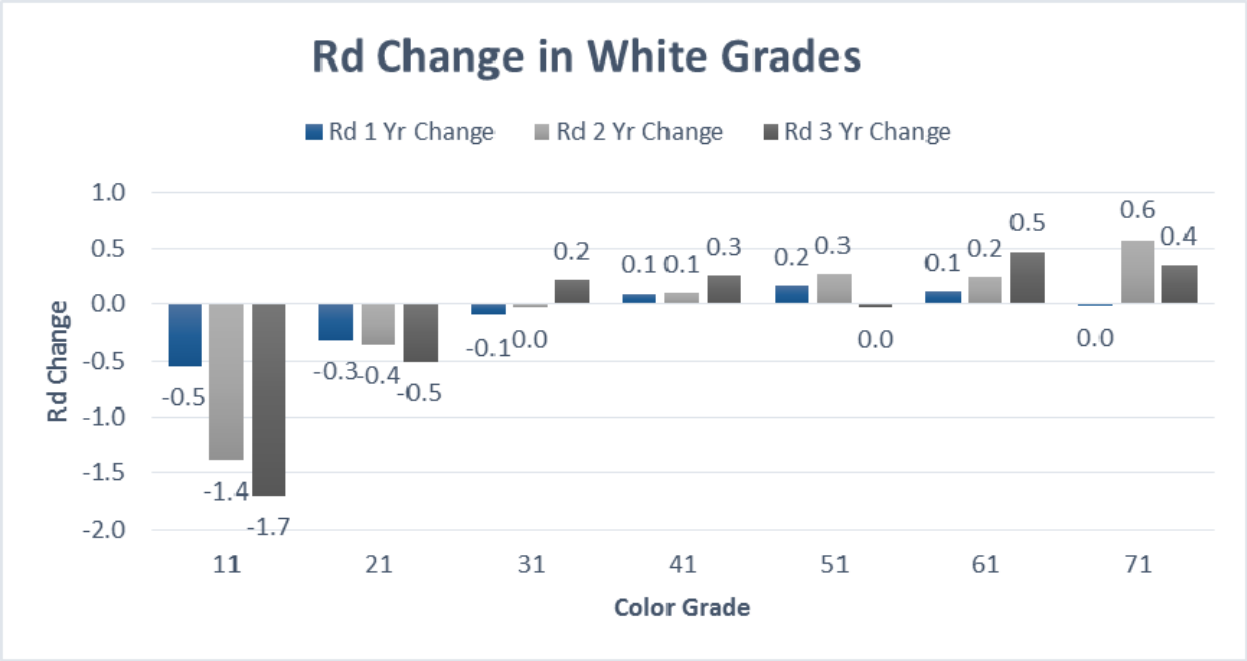

Figure 3. 1, 2, and 3 year changes in Rd for white grades.

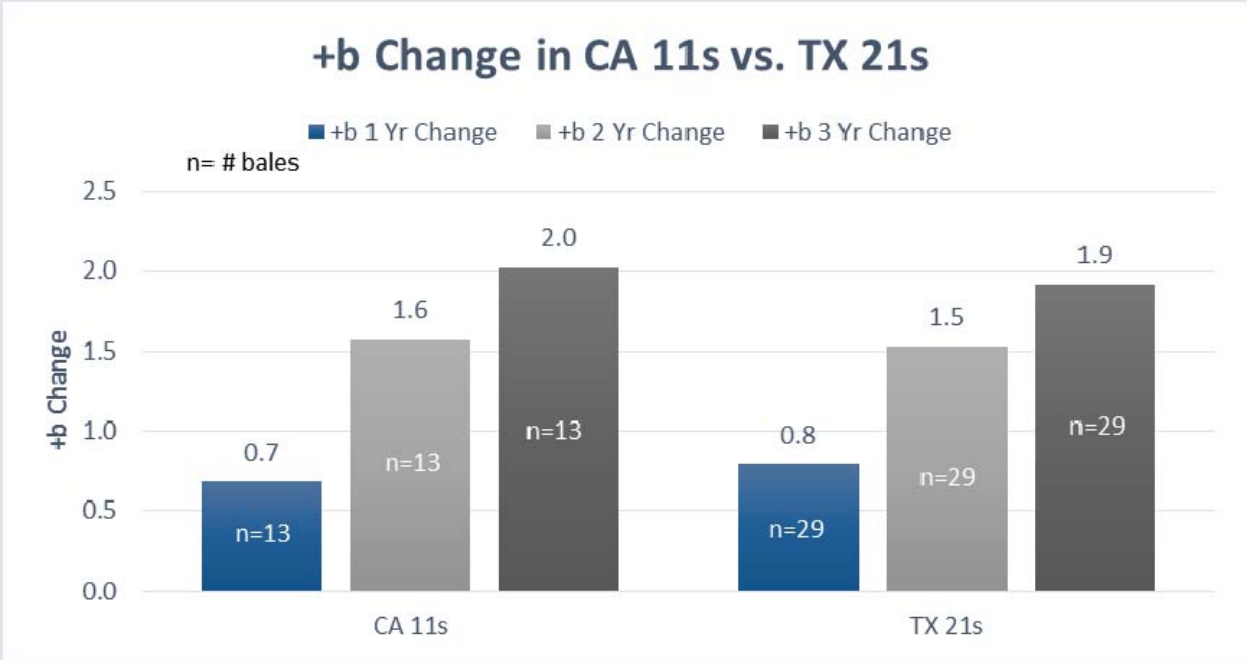

Figure 4. 1, 2, and 3 year changes in +b for California 11s versus Texas 21s.

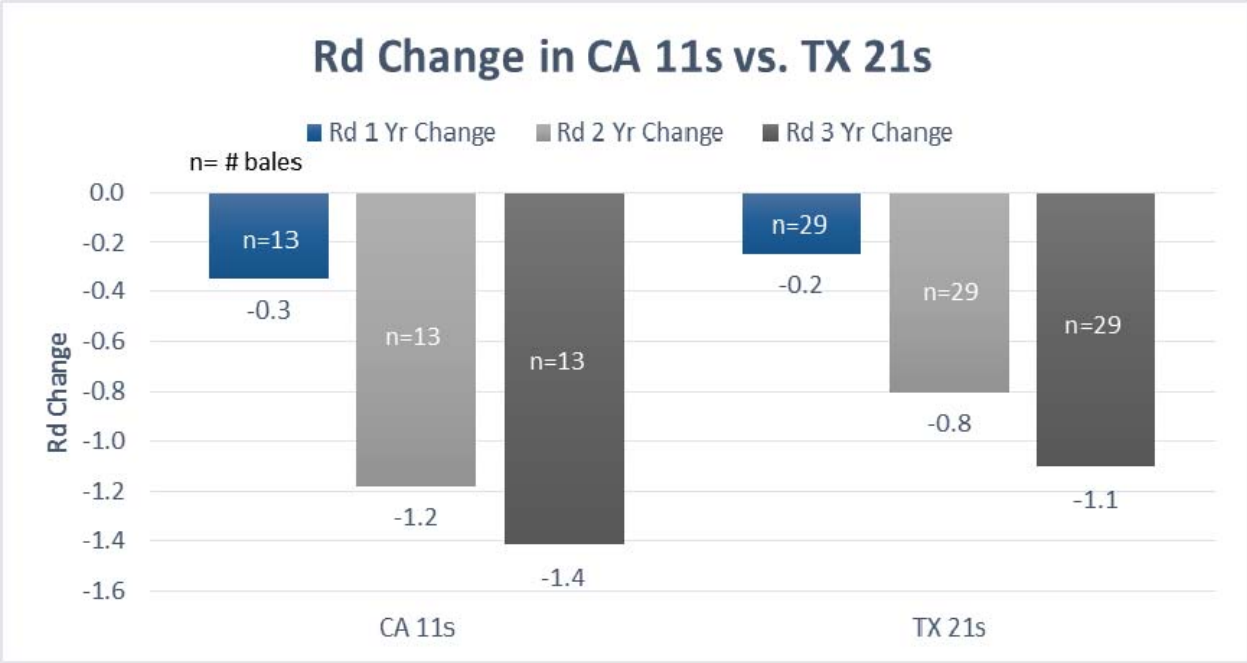

Figure 5. 1, 2, and 3 year changes in Rd for California 11s versus Texas 21s.

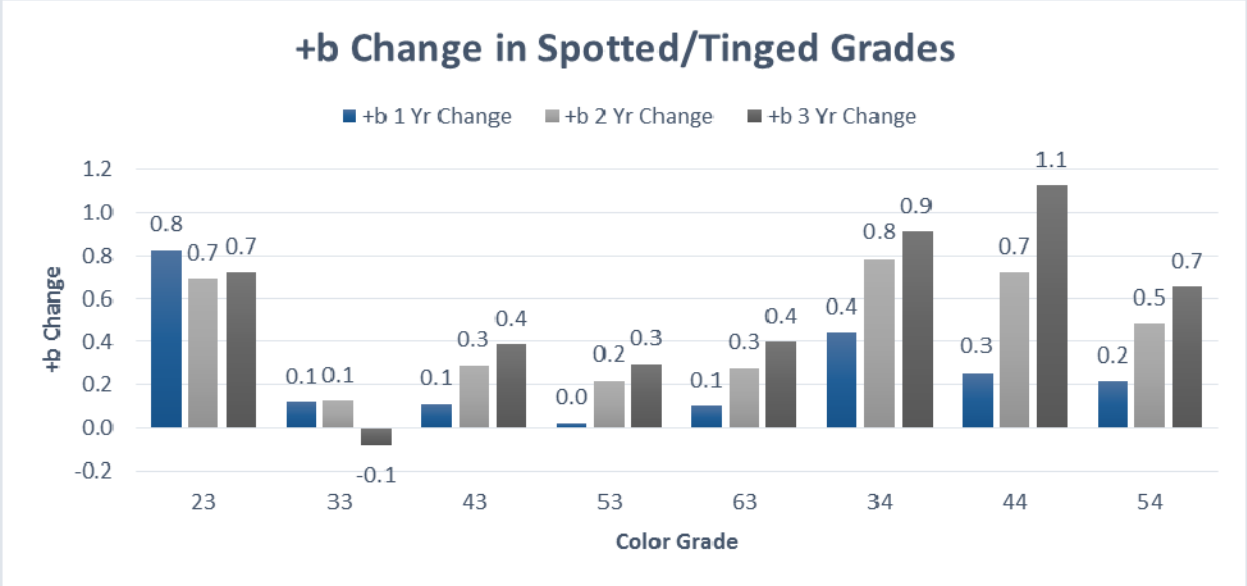

Figure 6. 1, 2, and 3 year changes in +b for Spotted/Tinged Grades.

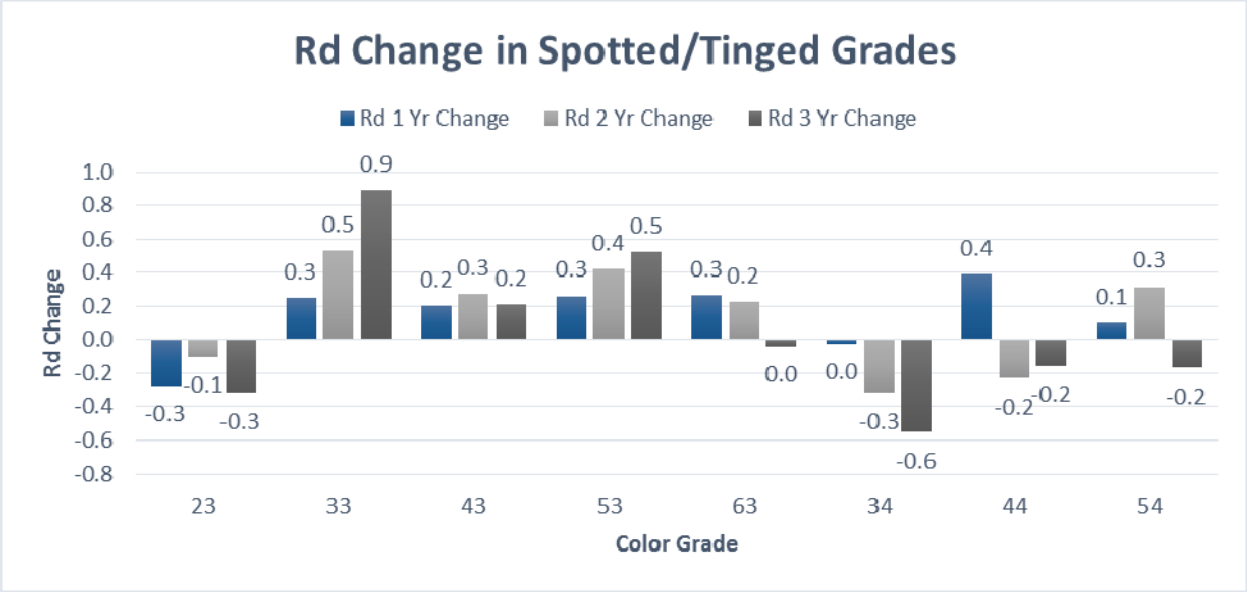

Figure 6. 1, 2, and 3 year changes in Rd for Spotted/Tinged Grades.

Figures 7 through 11 show color drift results of selected bales plotted on the Upland color grade conversion chart. The x-axis is +b and the y-axis is Rd. The solid symbols on the chart are the resulting color readings taken upon receipt of the freshly ginned bale (round circle) and then each year after (triangle is year 1 color and diamond is year 2 color). The arrows between the solid symbols show the direction of the color movement.

Figure 7 is a California bale showing a 1.6 increase in +b and a -1.4 decrease in Rd which is close to average for all California bales (from this study) in this region of the color chart. The majority of movement for the Figure 7 bale occurred after the first year of storage. Figure 8 is another California bale showing a higher than average amount of color drift. This bale had +b and Rd changes of 2.5 and -1.8, respectively. Most of the movement of this bale occurred in the first year. Figure 9 is a Texas cotton bale with near normal drift for Texas bales (from this study) in this region of the color chart. The drift in +b and Rd for this bale was 1.7 and -1.0, respectively. Figure 10 is a bale from Texas with an extreme color drift of 4.2 +b units and -3.5 Rd units. Of all 307 bales in this study, this bale had the largest color drift. Figure 11 is a color grade 41 bale from the Southeast showing average color movement for cotton in this region of the color chart with an increase of 0.6 +b units and a very slight increase in Rd of 0.1 units.

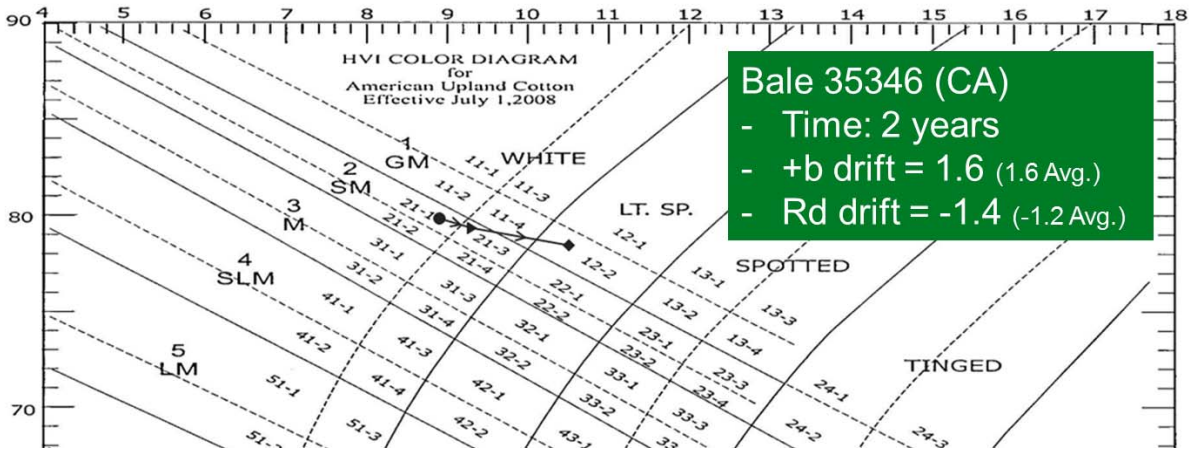

Figure 7. Color movement of a California bale with near average movement for its color grade.

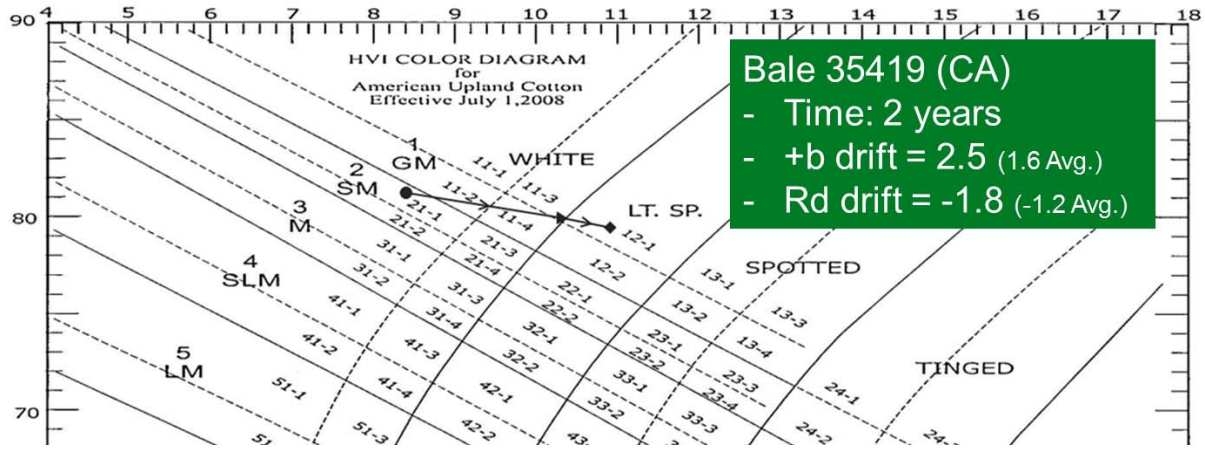

Figure 8. Color movement of a California bale with greater than normal movement for its color grade.

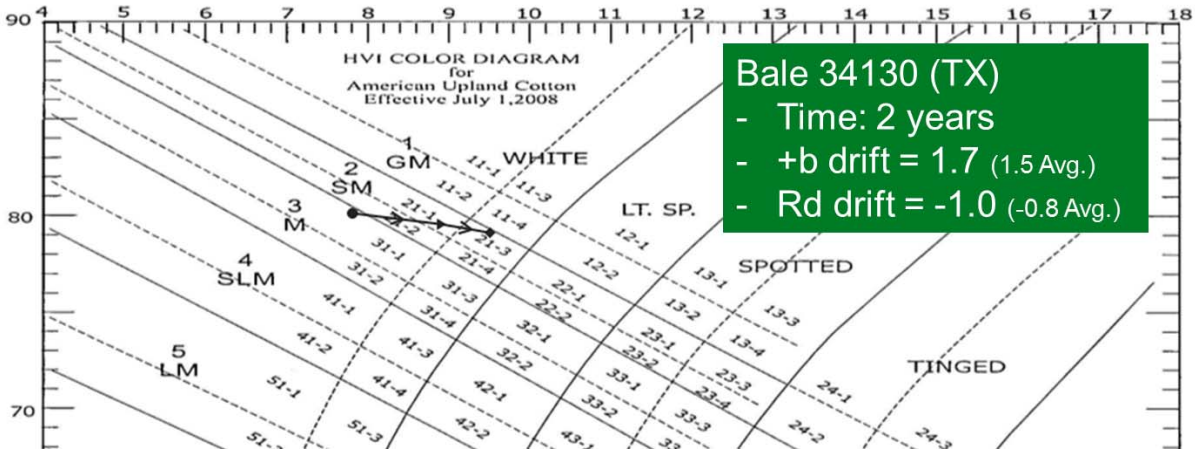

Figure 9. Color movement of a Texas bale with near average movement for its color grade.

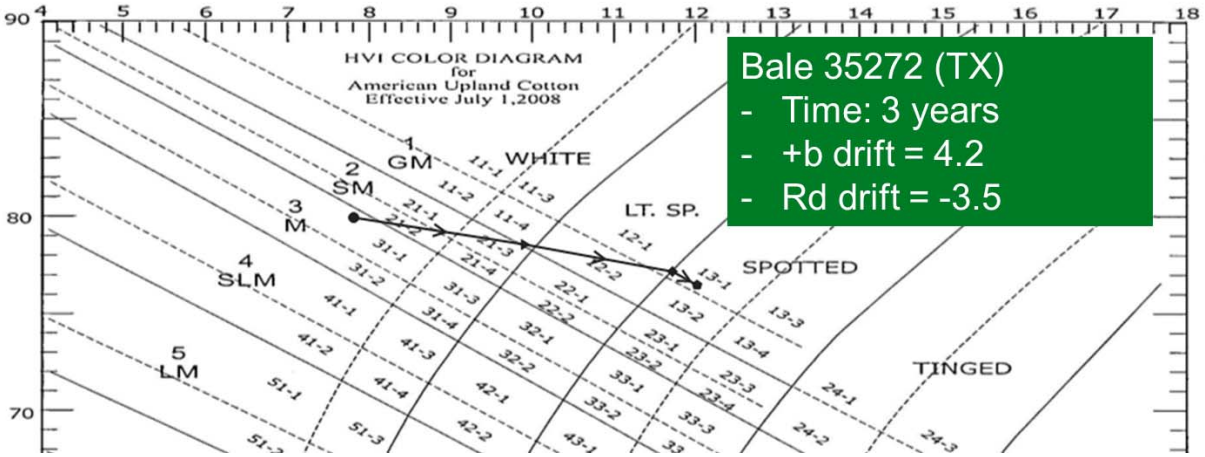

Figure 10. Color movement of a Texas bale with extreme color movement.

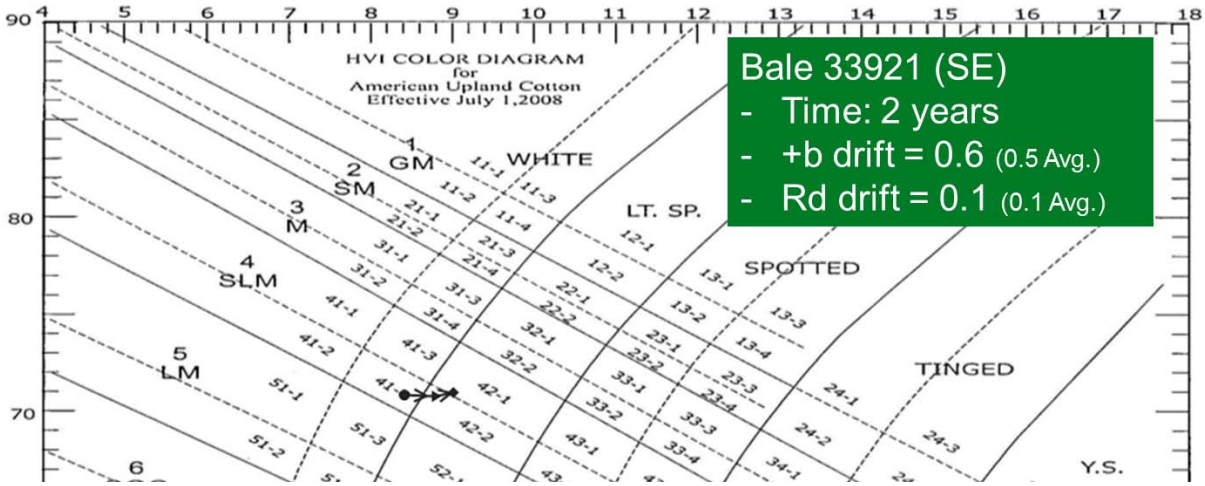

Figure 11. Color movement of a bale from the Southeast U.S. with near average movement for a 41 color grade.

Summary

This study shows various amounts and rates of cotton color change for different cottons. Although many yet to be understood variables influence how cotton color changes, this study does identify that a general relationship exists between color drift and initial cotton color. The ability to reliably predict the amount and rate of color drift in a cotton bale would be of value for textile processing. However, achieving reliable predictability is difficult, at least for now, due to the lack of understanding of the known and probably some unknown variables that influence cotton color drift.