ASSESSING THE QUALITY OF BURLEY TOBACCO PART 1: GRADE INDEX AND ASSOCIATED FACTORS[1]

TOBACCO SCIENCE

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This study determined an average yearly grade index (GID) from sales data for burley tobacco for the years 1959 - 1990. This index was used as a quality measure for each crop year. Several leaf-group, leaf-color, and seasonal-crop variables were significantly correlated with GID. Within the leaf groups, the leaf and lugs categories had a positive effect on GID, while tips, nondescript, and a combined group (TNM) had negative correlations. A tradeoff existed between these leaf groups in relation to the grade index. For the color groups, the tan groups within the lugs and leaf categories (CF, BF) and the tannish-red leaf group (BFR) had significant positive correlations with GID, while green color in the leaf, tips, and flyings groups had significant negative correlations with GID. Total crop production area had a significant negative correlation with GID, while it was positively correlated with the undesirable leaf groups of tips, nondescript, and TNM. This indicated that market quality was reduced when production area increased. The significantly correlated variables were used to develop a regression equation to predict GID. The equation had a regression coefficient of 0.935, and it predicted GID reasonably well for the 32-year period.

Additional key words: *Nicotiana tabacum*, burley tobacco, quality, grade index.

INTRODUCTION

The quality measure of any burley tobacco crop is impacted by several factors. Among these are the planting date, the growing environment, the harvest date and environment, the type of curing environment, and the manner in which the crop is stripped. In any year these factors vary, and they may combine to affect the market quality of the crop. Often producers make harvesting decisions based on labor supply, which might force them to harvest their tobacco before the crop is mature or during undesirable weather conditions. If the factors that directly affect crop quality could be identified, they might prove beneficial as a predictive tool for both the producer and researcher in terms of better crop quality and improved economic returns.

Burley tobacco is traditionally sold in grades that are indicative of the quality of the crop. Each grade is comprised of a leaf, a color, and a quality group. The leaf group represents stalk position and is somewhat indicative of the leaf maturity. The color group reflects the individual leaf structure and maturity, while the quality group indicates the condition of the tobacco within the leaf and color groups. The tobacco is usually graded on the market or warehouse floor by official graders from the grading service of the United States Department of Agriculture (USDA). The returns to the producer are based on the weight of tobacco in each grade and the price the tobacco companies are willing to pay for it.

There are approximately 110 to 115 grades that may be used each year. Many of these grades are similar in quality considerations, but with the many different combinations it has been difficult to define overall crop quality. Attempts have been made to use average leaf prices for various grades as a quality measure, but this does not always distinguish the amount of high or low quality tobacco present in a given crop because of the effects of supply and demand. Bowman et al. (4) established a grade index for burley tobacco to address this problem. Their procedure was to assign a numerical value to each leaf type as well as to each color and quality group, depending on the desirability of the grade. The index presents a means for measuring the overall quality of an individual crop, and it provides a basis for comparison of the amount of desirable tobacco each year contains.

The objectives for this study were (1) to compute a yearly grade index for burley tobacco and use it as a comparison measure of crop quality between years, (2) to identify and quantify the leaf and color variables that are significantly correlated with the yearly grade index, and (3) to establish a predictive model that will determine yearly grade index as a function of the correlated variables.

MATERIALS AND METHODS

The purpose of this paper was to use gross sales data from 1959 - 1990 by individual color and grade, and to determine which of these factors or combinations of factors had the greatest impact on crop quality. An average yearly grade index (GID) was computed for each year, and it was used as a quality measure of each crop. Factors that affect GID were identified using Pearson correlation coefficients (5), and they were used in developing a mathematical model to predict GID. Because it was not known what factors would affect GID, many combinations were considered. These are detailed in the following discussion along with assumptions made in quantifying the different variables.

The GIDs for 1959 - 1990 were determined using burley sales data from eight states (Ind., Ky., Mo., N.C., Ohio, Tenn., Va., & W.Va.) as reported by the USDA Tobacco Market Review (2). A computer program was written to calculate the numerical value of each grade as defined by Bowman et al. (4). GIDs were determined as follows: First a product was calculated using the percentage of a grade sold in a given year and the numerical value assigned to that grade. Then, the average index was found by summing the products for each grade appearing that year and dividing by 100 percent. Weighting each GID in this manner provided a measure of the crop quality for a given year. For years with a larger proportion of high quality tobacco, the GID was higher than in years where there were more undesirable grades. It was assumed that the tobacco harvested at any location followed the GID for that year.

Eight leaf group variables were considered using the percentage of each leaf category sold per year (2). These were flyings (FLY), cutters or lugs (LUG), leaf (LEA), tips (TIP), mixed (MIX), nondescript (NON), miscellaneous (MIS), and a combined leaf category (TNM) comprised of the sum of the tips, nondescript, and miscellaneous groups. For 1978 and subsequent years, MIS was subdivided into no-grade (NOG), waste, scrap, and unsound groupings. Only NOG contributes to the grade index with a numerical value of one. Prior to 1978 percentages in MIS were all assigned a grade of NOG when calculating GID.

Five major color groups (green, tan, buff, red, tannish-red) were identified by the sales percentage of the color category

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sold per year (2). These color categories were further subdivided by leaf group for a total of 15 color-leaf group combinations. For example, greenish color categories were identified to be those leaf groups having the standard color grades of V, VF, VR, G, GF, and GR. The percentage of these color grades were summed within a leaf group and designated as CGR (lugs), BGR (leaf), TGR (tips), and XGR (flyings). This procedure was repeated for each major color category. The percentage of flyings and lugs sold with buff color were identified as XL and CL, respectively. Major tan groupings were summed for flyings, lugs, leaves, and tips and designated as XF, CF, BF, and TF, respectively. Major red groupings included leaves (BR) and tips (TR) with red color. Tannish-red color percentages were also computed for leaves (BFR), tips (TFR), and the mixed group (MFR).

Seasonal crop variables for burley tobacco were also considered as reported by the USDA Crop Reporting Board (1). These were the yearly (1959 - 1990) total harvested crop area (TAREA) in hectares and average crop yield (TYLD) in kg/hectare.

RESULTS AND DISCUSSION

The GIDs had an average value of 59.4 for the 32 years, and they ranged from 68.4 in 1967 to 50.2 in 1983 (**Figure 1**). Several different leaf and color groups were related both to the grade index and to each other, and these will be discussed by the appropriate group.

Leaf Group Variables

Significant correlations were expected between GID and the various leaf categories. **Table 1** presents the correlation coefficients with the GID for the eight leaf groups, as well as the average percentage of each leaf group sold per year. LUG and LEA had a significant positive correlation with GID while TIP, NON, and TNM were significantly correlated in a negative fashion (**Table 1**).

The leaf groups most significantly affecting GID were LUG and TNM. **Figure 1** illustrates this positive correlation between GID and LUG. Lugs are a desirable leaf category, and on the average they constitute about 18% of yearly sales. **Figure 1** also depicts the negative correlation between GID and TNM, and it shows a slight decline in TNM over the 32-year period. The groups comprising the TNM category are less desirable tobacco, and any increase in this group is detrimental to crop quality.

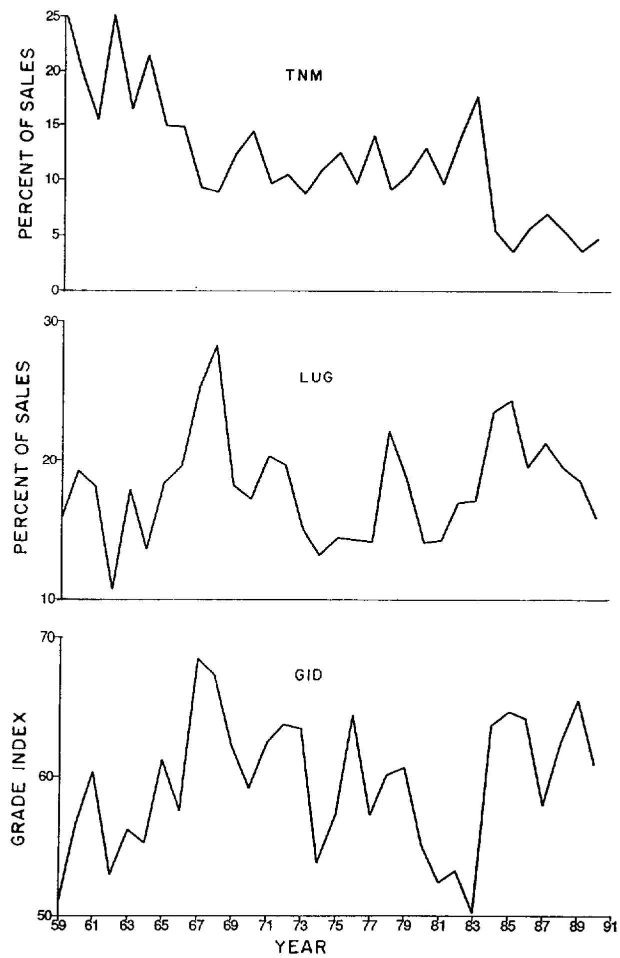
The correlations of LUG and TNM with GID indicate a tradeoff between these groups in relation to the numerical grade index. Further analyses found significant negative correlations between TNM and LUG, and between TNM and LEA (**Table 2**). A possible explanation for these correlations is that where growing conditions are favorable for crop maturity, LUG and LEA would represent a higher percentage of harvest, while TNM would be lower, resulting in a higher quality crop.

Table 1. Correlations for various leaf groups with the yearly grade index (GID) and average group sales per year, 1959 - 1990.

Leaf Group Variable	Correlation Coefficient with GID	Average Sales per Year
		---%---
FLY	0.0131	10.9
LUG	0.6474**a	18.0
LEA	0.3731*	48.9
TIP	-0.5313**	4.8
MIX	-0.1423	10.5
NON	-0.5279**	3.3
MIS	-0.3023	3.5
TNM	-0.6747**	11.7

a * = correlation significant at the 5% level;
** = correlation significant at the 1% level.

Figure 1. Average yearly grade index (GID), and sales percentages of lugs (LUG) and tips, nondescript, & miscellaneous (TNM), 1959-1990.



FLY had little effect on the grade index (**Table 1**), but it had a significant positive correlation with TIP, NON, and TNM (**Table 2**). This indicates that for growing seasons where the crop has a higher percentage of TNM, conditions would be favorable for an associated increase in FLY.

Leaf Color Variables

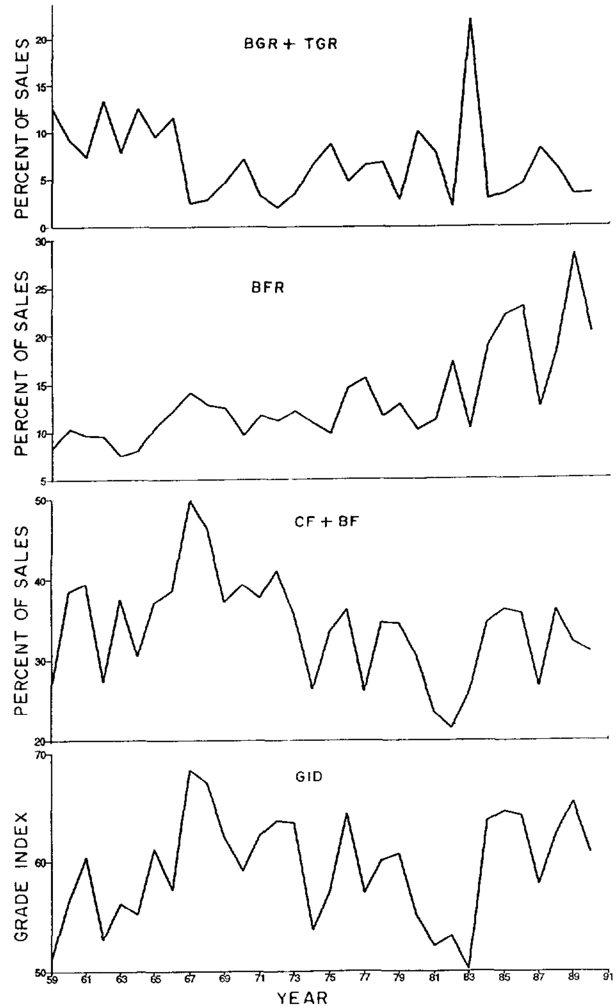
Table 3 presents the correlations of GID with the 15 major color groups. On a percentage basis, the largest color groups sold (**Table 3**) were the tan groupings (CF and BF) within the LUG and LEA categories and the tannish-red group (BFR) also in the LEA category. These are very desirable colors, and each had a significant positive correlation with GID. **Figure 2** shows the positive effect of the sum of the tan groups (CF + BF) as well as that for the tannish-red group (BFR) on GID for

Table 2. Correlations for lugs (LUG), flyings (FLY), and leaves (LEA) with tips (TIP), nondescript (NON), and the sum of tips, nondescript, and miscellaneous (TNM), 1959 - 1990.

Leaf group Variable	Correlation Coefficient with FLY	Correlation Coefficient with LUG	Correlation Coefficient with LEA
TIP	0.5904**a	-0.3826*a	-0.4630**a
NON	0.5566**	-0.3556*	-0.3907*
TNM	0.6202**	-0.4567**	-0.5964**

a * = correlation significant at the 5% level;
** = correlation significant at the 1% level.

Figure 2. Average yearly grade index (GID), and sales percentages of tan leaf & lugs (CF+BF), tannish red leaf (BFR), and green leaf & tips (BGR+TGR), 1959-1990.



the 32-year period. BFR had minimal effect on grade index until the mid-1980s when there was a significant increase in sales of this group. Some of the increase in BFR was at the expense of the tan groups, and this was probably the result of a demand for darker colors by the tobacco companies during the last decade.

Three of the four green color categories had significant negative correlation coefficients with GID (**Table 3**). The most significant of these was BGR. LEA generally comprises the largest category sold in a given year (**Table 1**), and when it contains an undesirable color, the quality index would be lower. TGR and TR also showed a significant negative impact on GID, and this was due somewhat to TIP already having a significant unfavorable effect on GID (**Table 1**) (i.e., green tips are worse than tips alone). While the percent of BGR and TGR was small, the negative impact of their sum on GID is clearly demonstrated in **Figure 2**. Clearly, if the factors causing these lower quality and color groupings were identified, this would provide a good measure of crop quality in a given year.

Seasonal Crop Variables

The average crop area harvested (TAREA) was 108.7 x 10^3 hectares, and the average crop yield (TYLD) was 2416.5 kg/ha for the 32 years considered. **Table 4** presents correlations for TAREA and TYLD between GID, the eight leaf groups, and four of the color groups that were

Table 3. Correlations for various leaf color group with the yearly grade index (GID) and average group sales per year, 1959 - 1990.

Leaf Color Variable	Correlation Coefficient with GID	Average Sales Per Year
		---%---
CGR	-0.2314	0.5
BGR	-0.7257**[a]	5.0
TGR	-0.6179**	1.8
XGR	-0.3634*	0.1
BFR	0.5198**	13.3
BR	0.0898	6.4
TFR	0.0890	1.2
TR	-0.3727*	1.5
MFR	-0.2183	2.4
XL	0.2660	1.3
XF	0.0006	8.9
CL	0.2800	0.5
CF	0.7555**	14.0
BF	0.6069**	20.0
TF	-0.2407	0.2

[a] * = correlation significant at the 5% level;
** = correlation significant at the 1% level.

significantly correlated with GID. TAREA showed a significant negative correlation with GID and LUG, while it was positively correlated with TIP, NON, and TNM. **Figure 3** illustrates the inverse correlation between GID and TAREA. TAREA reached maximums of approximately 138 x 10^3 hectares in 1962, 1963, and 1982, and minimums around 98 x 10^3 hectares in 1970, 1971, 1986, and 1987.

The negative correlation between TAREA and GID (**Table 4**) indicated that as more land area was brought into production the overall crop quality was reduced. This conclusion is reinforced by the positive correlations between TAREA and the undesirable leaf groups (TIP, NON, and TNM), and by the negative correlations between TAREA and

Figure 3. Average yearly grade index (GID) and harvested crop area (TAREA), 1959-1990.

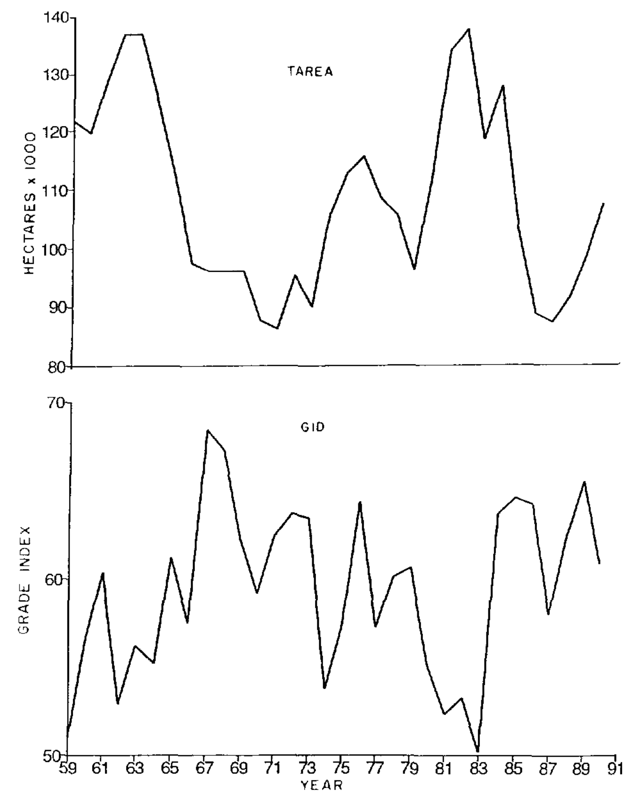


Table 4. Correlations for average crop area (TAREA) and crop yield (TYLD) with the yearly grade index (GID) and various leaf and color group variables, 1959 - 1990.

Variable	Correlation Coefficient with TAREA	Correlation Coefficient with TYLD
GID	-0.5899**[a]	0.3429
Leaf Group		
FLY	0.0748	-0.1285
LUG	-0.4027*	0.1645
LEA	-0.1991	0.0035
TIP	0.5145**	-0.5684**
MIX	-0.0601	0.2276
NON	0.4951**	-0.5331**
MIS	0.0049	0.5857**
TNM	0.5298**	-0.3467
Color Group		
BGR	0.2921	-0.3619*
TGR	0.4261*	-0.6088**
TR	0.5402**	-0.4137*
CF	-0.4772**	0.2978

[a] * = correlation significant at the 5% level;
** = correlation significant at the 1% level.

LUG. In seasons where the crop production area was increased, the tobacco was often grown on marginal land, and it was often harvested at non-optimum maturity because of a longer harvest period. **Table 4** also shows correlations that indicate a tradeoff between the tan and the green or red color groups. While some of the color correlations were due to changes in their respective leaf groups, it appears that as crop area increased, there were higher percentages of the less desirable colors. This may be due in part to overcrowding of the tobacco in available barn space, which contributes to less desirable colors and a lower quality crop.

TYLD was not significantly correlated with GID (**Table 4**), pointing out that yield alone is not a predictor of quality. TIP and NON were negatively correlated with TYLD, while MIS was positively correlated. As one would expect, this indicates that growing seasons with larger percentages of immature and over mature leaves would yield less. No correlation was found between TAREA and TYLD.

Predictive Model for Grade Index

Once the variables having significant correlations with GID had been identified, a stepwise regression (5) was used that maximized the coefficient of determination (r^2) for the resulting five-variable equation:

$$GID = 41.9 + 0.245\ BFR + 0.594\ CF + 0.442\ BF - 0.477\ TNM + 1.79\ TR \quad \textbf{(Equation 1)}$$

where:

GID is the yearly average grade index,

BFR is the yearly percentage of burley sold in the leaf category with tannish-red color,

CF is the yearly percentage of burley sold in the lugs category with tan color,

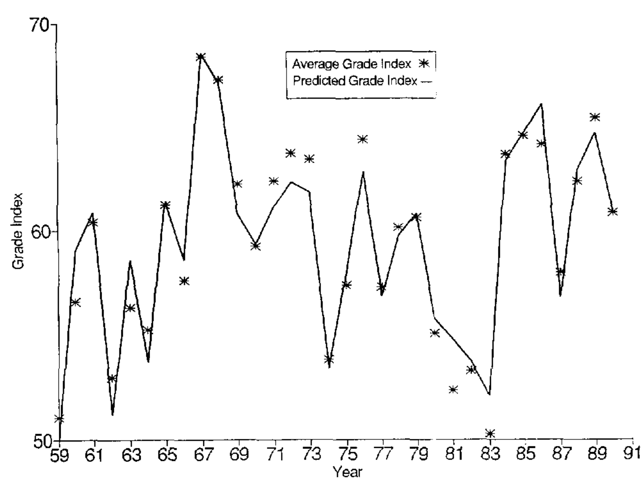
BF is the yearly percentage of burley sold in the leaf category with tan color,

TNM is the sum of the yearly percentage of burley sold as tips, nondescript, and miscellaneous, and

TR is the yearly percentage of burley sold in the tips category with red color.

The r^2 for **Equation 1** was 0.935, and overall it predicted GID well (**Figure 4**). Only for 1960, 1963, and 1981 did the model miss predicting GID by two or more points. The positive benefit for researchers working in this area is the model's ability to predict GID for a given year using easily identified input variables. However, the negative aspect to **Equation 1** is its inability to predict GID for future years. The input variables can be determined only after sales have been complete for a given year, making the equation inappropriate for an ongoing season. If growing and harvest season variables that impact both the grade index and the equation input factors could be identified, the model would be a more useful tool for researchers and producers. These aspects are addressed in Part 2 of this study (3).

Figure 4. Observed average yearly grade index (GID) for 1959-1990, and predicted values according to Equation 1 (see text).



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