Peanut Science (1982) 9, 27-30

The Seed Hull Maturity Index as an Estimator of Yield and Value of Virginia-type Peanuts[1]

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ABSTRACT

The Seed Hull Maturity Index (SHMI) is a low cost maturity estimation method which has been shown to be correlated to yield and value per hectare using short term studies. To test the relationship of SHMI to yield and value on a long term basis, an equation was developed for deriving SHMI from 9 years of market grade information. Comparison of observed and derived SHMI values produced an R of 0.93. Among the cultivars used only Florigiant, NC6, and NC7 are either major commercial cultivars or cultivars being evaulated commercially. The data from this study confirmed that SHMI optimum values must be determined for each cultivar of interest. SHMI was shown to best estimate value per hectare. The value estimation equations for Florigiant and NC6 are given. The SHMI at which maximum value occurs is 3.0 for Florigiant and 3.1 for NC6. The SHMI at which maximum yield occurs is 2.7 for both cultivars.

Key Words: *Arachis hypogaea*, groundnut, market value, harvesting, digging.

The Seed Hull Maturity Index (SHMI) has been shown to be a low cost maturity estimation method (5) and to be correlated to yield and value per hectare for selected cultivars grown in the Virginia-Carolina region during 1977 and 1978 (6). A similar method published by Barr (1) uses average kernel weight as an indicator of time to harvest peanuts. Both the Barr method and the SHMI method have about the same degree of accuracy and have to be adjusted for individual cultivars. Published literature on SHMI has been confined to short-term small plot studies which have suggested that SHMI may apply to commercial peanut production (5-8). Correlations between yield and SHMI suggest maximum yield occurs between a SHMI of 2.7 and 2.9 for the cultivar Florigiant.

There is much data including yield and market grade information available from peanut yield trials. SHMI may

[1]Paper Number 8174 of the Journal Series of the North Carolina Agricultural Research Service, Raleigh, NC 27650. The use of trade names in this publication does not imply endorsement by USDA or the North Carolina Agricultural Research Service nor criticism of similar ones not mentioned.

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be derived from market grade information since its determination involves measurement of hull and kernel weights. These derived SHMI may be used for extensive evaluation of the relationship between yield or value per hectare and SHMI. This paper presents such evaluations based on data from yield trials involving 5 cultivars and 11 locations over a period of 9 years.

Materials and Methods

Derivation of SHMI from Market Grade Data

SHMI was estimated from market grade information with the following equation.

SHMI = (SMK + SS + DAM)/(100% - MEAT) + OK   Eq. 1

where SMK = % sound mature kernels,
SS = % sound splits,
DAM = % damage,
MEAT = % meat content, and
OK = % other kernels.

The OK fraction was added to the hull fraction to more closely approximate the standard SHMI method (6) which includes in the hull fraction those fruit which contain small, shrivelled kernels.

Data obtained from a Florigiant, NC2, and NC5 cultivar yield study conducted on small plots at Lewiston, NC during 1977 and 1978 were used to test the correlation between derived SHMI and standard field determinations of SHMI. During the yield study, separate samples were collected from the plots to determine the SHMI and the market grade data.

Correlations of SHMI to Yield, Value and Price

Market grade data and corresponding yield data from yield studies conducted in North Carolina and Virginia were used to determine the correlation between yield, price per kg or value per ha and derived SHMI using 1426 data points. Because the yield studies were made by three different laboratories it was felt that there may be a problem with non-homogeneous variances and possibly some spurious observations. As a precaution, a number of the regression equations were fitted first by ordinary least squares (3) and then by using some of the robust techniques described by Huber (4). These latter methods are much less sensitive to violations of the least squares assumptions such as non-homogeneity and presence of outliers.

The data used in the study were collected for NC5, NC17, and Florigiant between 1971-79, for NC6 between 1973-79 and for NC7 between 1974-79. Field tests were made in Chowan, Halifax, Bertie, Edgecombe, Martin and Northampton Counties, NC; and Greenville, Southampton, Suffolk, Surry, and Sussex Counties, VA. Data were not available from all 11 locations for every year. All data were gathered from small plots (22-28 sq. m). Yield and marketing data were obtained from machine-harvested plots consisting of two rows 8.53 m long. Recommended cultural practices for the Virginia-Carolina area were used on all tests. Samples were graded using standard Federal-State Inspection Service procedures. Price and value were determined using the 1979 price support schedule for all samples.

Results and Discussion

A regression of standard SHMI and SHMI derived from Equation 1 gave a correlation coefficient of 0.93. The high correlation coefficient indicates that the equation for estimating field SHMI from marketing grade values accounts for about 86% of the variation. Thus the derived values can be considered reasonable estimates of the true SHMI.

SHMI-Yield Relationship

The following two regressions of yield (kg/ha) on SHMI were obtained from the 1426 observations by ordinary least squares (Eq. 2) and the robust techniques (Eq. 3):

Yield = -1889 + (4256 x SHMI) - (724 x SHMI^2)   Eq. 2

Yield = -2106 + (4427 x SHMI) - (754 x SHMI^2).   Eq. 3

Both equations have similar linear and quadratic terms. The SHMI for maximum yield is 2.9 for both equations. From these results and similar tests on subsets of the data it was concluded that ordinary least squares was adequate and was incorporated as an analysis step on all remaining analyses.

In order to present the data in a more concise form, all of the 1426 data points were grouped into intervals approximately equal to one-half a standard deviation unit (0.1) of SHMI values. The data points in each group were averaged. The averaged values were used to compute the regression equations shown hereafter. The reader is referred to Cleveland and Kleiner (2) for a more detailed presentation of this statistical approach. Comparison of the yield prediction equation from non-averaged data (Eq. 2) and averaged data (Eq. 4)

Yield = -1378 + (4026 x SHMI) - (708 x SHMI^2)   Eq. 4

shows them to be numerically similar. This observation is supported by close agreement of the SHMI values for maximum yield (2.9 for Eq. 2 and 2.8 for Eq. 4). The mean of the 1426 non-averaged data points and the mean of the 184 data points from the average data were 3938 kg/ha and 3899 kg/ha, respectively. The two methods showed similar agreement for mean value per ha and mean price per kg.

A plot of the yield and SHMI data shows that the relationship between these two variables is curvilinear (Figure 1).

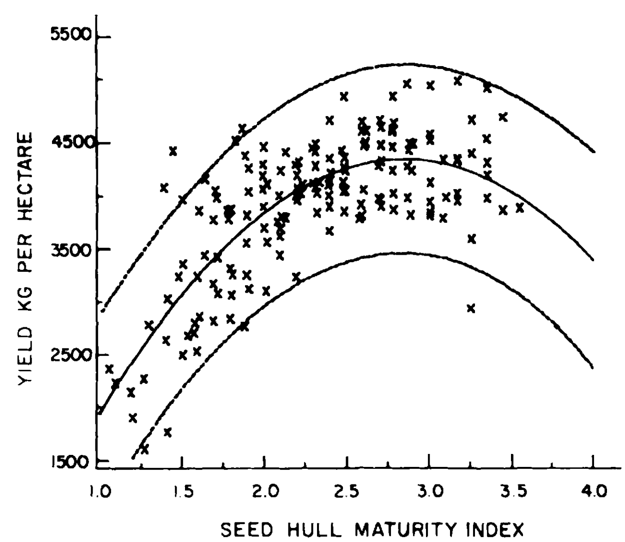

Fig. 1. Yield progression with SHMI.

SHMI-Price Relationship

The highly significant correlation (R = 0.98) between SHMI and price per kg indicates that the peanut grower can use SHMI to estimate the price per kg ha will receive at the buying station. Based on the 1979 price support schedule, the price estimation equation would be:

Price = 0.19 + (0.13 x SHMI) - (0.015 x SHMI^2).   Eq. 5

SHMI-Value Relationship

Location and Year Effects - Environmental differences, diseases and cultural practices tend to cause the value of peanut crops to vary from year to year and location to location. However, a general relationship between value of the crop per ha and SHMI appears to exist. The constancy of this relationship at four locations that provided the bulk of the observations and over the nine years can be seen in Figure 2. While it is true that SHMI values were larger in

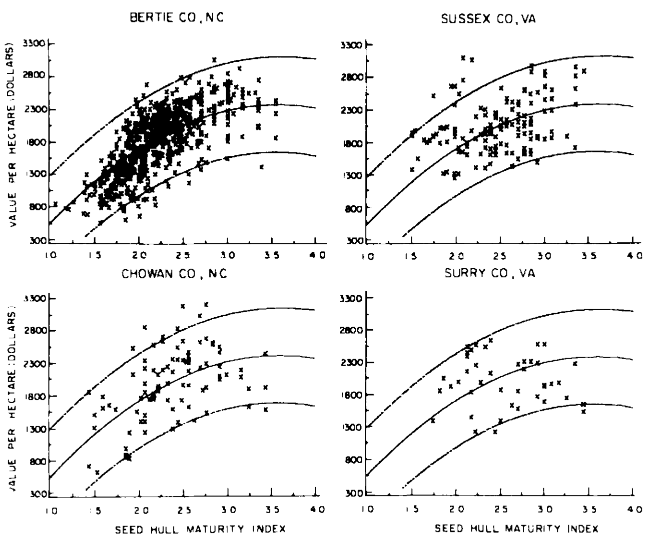

Fig. 2. Fit of selected location data to the total data quadratic equation curve for the SHMI-value relationship with 95% confidence limits.

some locations and in some years than in others, the plotted points for value vs. SHMI tend to scatter along a common line.

Value - Peanut producers often make the error of assuming that maximum yield gives maximum value for the peanut crop. The potential use of SHMI to estimate the point of maximum value is illustrated in Figure 3.

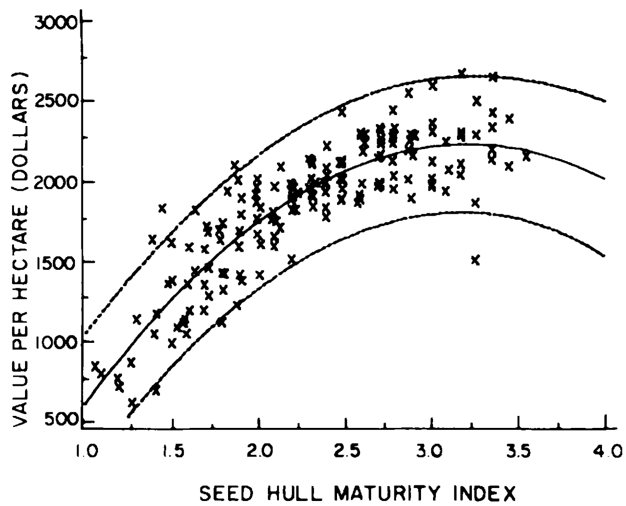

Fig. 3. Value progression with SHMI.

$$\text{Value} = -1048 + (1860 \times \text{SHMI}) - (289 \times \text{SHMI}^2) \quad \text{Eq. 6}$$

Comparison of the SHMI for maximum yield (2.8) and for maximum value (3.2) suggests that a significant time interval exists between these two points. Since the values for maximum yield and for maximum value are $2215/ha and $2262/ha, respectively, waiting for maximum value results in a $47/ha increase in value. Shear and Miller (9) have observed with Jumbo Runner peanuts that maximum yield was reached before maximum shelling percentage or maximum percentage of extra large seed was obtained.

Although the SHMI for maximum value may seldom be achieved, Figure 3 suggests that value progression for each year will generally follow the total data regression curve, and that peanut producers can use the SHMI value to estimate the potential for value increase. This estimated potential for value increase can then be balanced against weather forecasts, disease level, and other factors to decide when harvesting for a particular field should take place. On those exceptional years when the SHMI for maximum value is reached early, delayed harvest probably will not improve the value but may result in a loss to the peanut producer.

Within this paper we have used a composition of data obtained from several peanut cultivars to demonstrate the relationship between yield, price per kg, value per ha, and SHMI. However, our previously published evaluation (5) that SHMI optimum values for each peanut cultivar of interest must be determined has not been changed by this data analysis. Among the cultivars used in this study only Florigiant, NC6, and NC7 are either major commercial cultivars or are being evaluated commercially. Sufficient data to develop a value per ha - SHMI curve were available for only Florigiant and NC6. The estimation equations for Florigiant and NC6 are respectively:

$$\text{Value (Florigiant)} = -276 + (430 \times \text{SHMI}) - (71 \times \text{SHMI}^2) \quad \text{Eq. 7}$$

$$\text{Value (NC6)} = -108 + (301 \times \text{SHMI}) - (48 \times \text{SHMI}^2) \quad \text{Eq. 8}$$

The SHMI at which maximum value occurs is 3.0 for Florigiant and 3.1 for NC6. The SHMI at which maximum yield occurs is 2.7 for both cultivars. This maximum-yield value is in excellent agreement with the previously published values of 2.7-2.9 for Florigiant (5-8) and thus gives considerable support to the validity of the SHMI of 3.0 for maximum value. The regression curves for Florigiant and NC6 are given in Figure 4.

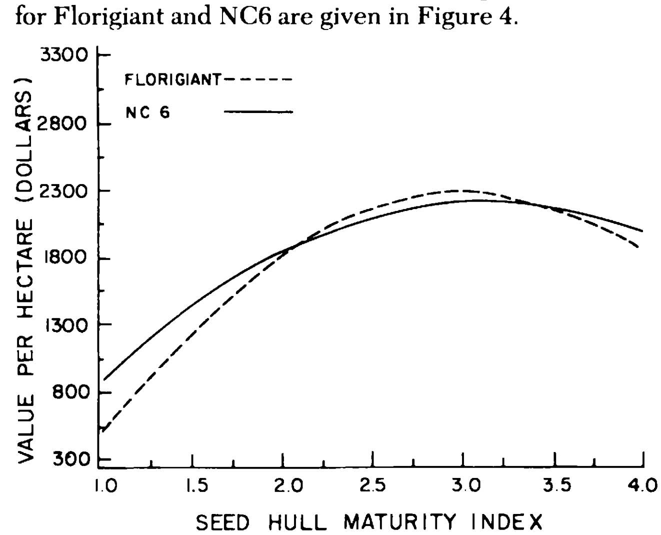

Fig. 4. The quadratic equation curves for Florigiant and NC6.

Literature Cited

1. Barr, H. D. 1962. The relation between kernel development and time of harvesting peanuts at Katherin, N.T. Aust. J. of Exper. Agric. and Animal Husbandard. 2:106-109.
2. Cleveland, W. S. and B. Kleiner. 1975. A graphical technique for enhancing scatter plots with moving statistics. Technometrics 17:447-454.
3. Cochran, W. G. 1971. *Sampling Techniques*. Wiley, 3rd ed., New York, NY.

4. Huber, P. J. 1977. *Robust Statistical Procedures*. Soc. Indust. Appl. Math. Philadelphia, PA 19103.
5. Pattee, H. E., J. C. Wynne, J. H. Young and F. R. Cox. 1977. The seed-hull weight ratio as an index of peanut maturity. Peanut Sci. 4:47-50.
6. Pattee, H. E., J. C. Wynne, T. H. Sanders and A. M. Schubert. 1980. Relation of the seed-hull ratio to yield and dollar value in peanut production. Peanut Sci. 7:74-77.
7. Sanders, T. H., E. J. Williams, A. M. Schubert and H. E. Pattee. 1980. Peanut maturity method evaluations. I. Southeast. Peanut Sci. 7:78-82.
8. Schubert, A. M. and C. L. Pohler. 1978. Comparison of maturity tests on three peanut cultivars in South Texas. Proc. Amer. Peanut Res. Educ. Assn. 10:55 (Abstract).
9. Shear, G. M. and L. I. Miller. 1959. Influence of time of planting and digging on the Jumbo Runner peanut. Agron. J. 51:30-32.

Accepted April 27, 1982