WHAT IS IN THE CORN JUDGE'S MIND?[1]

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In the spring of 1916, Prof. H. D. Hughes, of the Iowa Experiment Station, asked a number of experienced corn judges to score some five hundred ears of corn on the basis of what they thought the relative yields would be.[2] These five hundred ears of corn were field run, varying from only three or four inches in length to more than ten inches. The variety was the college strain of Reid. In addition to the scoring, complete measurements were taken of each ear. Among other things, there were determined the length and circumference of ear, weight of kernel, filling of the kernel at the tip (tip of kernel, not tip of ear), blistering of kernel, and starchiness. These ears were planted, an ear to a row, and in the fall of 1916, yields were secured.

The experiment was repeated in 1917.

The method of correlation coefficients is admirably adapted to interpreting data of this sort to discover just what is in an experienced corn judge's mind. It was found that the typical judge's score was correlated with various factors as follows: length of ear .7, circumference .4, weight of kernel .5, filling of kernel at tip 4, absence of blistering of kernel .2, absence of starchiness .3.

[1] Contribution from the editorial department of "Wallace's Farmer", Des Moines, Iowa. Received for publication, June 12, 1923.

[2] HUGHES, H. D. An interesting seed corn experiment. Iowa Agriculturist, 17: 424–425, 428. 1917.

When these results were obtained, it was determined to make out the score card which really existed in the judges' minds. The method used was the method of path coefficients as described in the January 3, 1921, issue of the JOURNAL OF AGRICULTURAL RESEARCH in the article "Correlation and Causation" by Sewall Wright. In using this method, it is necessary to have not only the correlation coefficients between the judge's score and the various ear and kernel characteristics, but also the inter-correlations between the various characteristics. The correlation between length and circumference was found to be .3, between length and weight of kernel .3, between length and filling of kernel at tip .2, between length and absence of blistering, .2, between length and absence of starchiness of kernel .2. The correlation between circumference and weight of kernel was found to be .2, between circumference and filling of kernel at tip .1, and there was practically no correlation between the circumference and absence of blistering or between circumference and absence of starchiness. Between weight of kernel and filling of kernel at tip, the correlation was found to be .4, between weight of kernel and absence of blistering .2, and between weight of kernel and absence of starchiness, .2. The correlation between filling of kernel at tip and absence of blistering was .5, and between filling of kernel at tip and absence of starchiness .6. Absence of blistering and absence of starchiness were found to be correlated to the extent of .5. The second and third decimals of these correlations were dropped in order to make the explanation presented herewith seem a little less formidable.

The following six equations are derived from the correlation coefficients as just given:

$$
\begin{aligned}
.7 &= \quad b + .3c + .3d + .2e + .2f + .2g \\
.4 &= .3b + \quad c + .2d + .1e + \quad - \\
.5 &= .3b + .2c + \quad d + .4e + .2f + .2g \\
.4 &= .2b + .1c + .4d + \quad e + .5f + .6g \\
.2 &= .2b + \quad - + .2d + .5e + \quad f + .5g \\
.3 &= .2b + \quad - + .2d + .6e + .5f + \quad g
\end{aligned}
$$

In the foregoing equations "b" stands for length, "c" for circumference, "d" for weight of kernel, "e" for filling of kernel at tip, "f" for absence of blistering, and "g" for absence of starchiness The figures on the left hand of the equations are in order, the correlations between the typical corn judge's score and length, corn judge's score and circumference, corn judge's score and weight of kernel, etc. It will be noted that on the right hand of the equations, the letters are qualified with the inter-correlations. For instance, in

the first equation the letter "c" carries with it the correlation between length and circumference, 3, and the letter "d" carries with it the correlation between length and weight of kernel, again .3, as it happens. These six equations are solved after the customary method of solving simultaneous equations and numerical values are obtained for "g," "f," "e," "d," "c," and "b." The values in this particular case are:

"b" (length) .541
"c" (circumference) .175
"d" (weight of kernel) .235
"e" (filling of kernel at tip) .171
"f" (absence of blistering of kernel) —.083
"g" (absence of starchiness) .083

According to Sewall Wright the best way to derive a score card from path coefficients is to determine the ratios between the different path coefficients and the total of all path coefficients (disregarding signs in adding for this purpose). In this case the total of the path coefficients, neglecting signs, is 1.288. Dividing each of the path coefficients by 1.288 and multiplying by 100, we get the following score card:

JUDGES' SCORE CARD

When Scoring Field Run Ears

Length	42.0
Circumference	13.6
Weight of kernel	18.3
Filling of kernel at tip	13.3
Blistering of kernel	6.4
Absence of starchiness	6.4
Total	100.00

It is interesting to note that while the simple correlation coefficients indicate that the judges took into account blistering of kernel as a damaging factor the path coefficients indicate that they looked on blistering as beneficial. The long ears with heavy kernels for which the judges had such a fondness tended to be freer from blistering than the short ears with light kernels and for that reason it appears on the surface that the judges did not like blistering. But when other factors are held constant it is found that there is a slight tendency for the judges to favor blistering. Doubtless this was carelessness on the part of these particular judges.

Yields were secured from the ears which these judges scored and the correlation coefficient between the yield and length of ear was .2, yield and circumference .15, yield and weight of kernel .4. yield and filling of kernel at tip .3, yield and absence of blistering .2, yield and absence of starchiness .2. Using the same six simultaneous equations as given in the foregoing, but substituting on the left-hand side these correlation coefficients just given and solving, the following path coefficients bearing on yield are obtained:

Length of ear	.048
Circumference of ear	.062
Weight of kernel	.311
Filling of kernel at tip	.112
Absence of blistering	.056
Absence of starchiness	.033

The total of these path coefficients bearing on yield is .622. Dividing the respective path coefficients by .622 and multiplying by 100 we obtain as a yield score card the following:

Length	7.7
Circumference	10.0
Weight of kernel	50.0
Filling of kernel at tip	18.0
Absence of blistering	9.0
Absence of starchiness	5.3
Total	100.00

The contrast between the yield score card and the judges' score card is interesting.

It will be noted that the tendency of the judges is to emphasize more than anything else, length of ear, whereas Mother Nature, judging merely from these two years' work with one variety of corn, lays her outstanding emphasis on weight of kernel. Over a period of years it may be that the judges are well warranted in making it a prime requisite that a seed ear in the central part of the Corn Belt should at least be eight inches long. But in case of an emergency, in a season when seed corn is scarce, it is probable that so far as that particular year is concerned, length of ear can be disregarded altogether. The important thing would seem to be to discard those ears carrying light kernels, especially if they have pointed tips, are blistered, and are starchy.

That the corn judges did not know so very much about the factors which make for yield is indicated by the fact that their scores were correlated with yield to the extent of only .2. The difficulty seems to be that they laid too much emphasis on length of ear and possibly also on some fancy points, which caused them to neglect placing as much emphasis on sound, healthy kernel characteristics as they should.

By using Wright's methods of path coefficients, it should be possible in the future to work out in very definite fashion, what really is in the minds of experienced corn judges. It is suggested that the things which really are in their minds are considerably different from the professed score card. It is realized of course that when the judges are working on sample of corn all of which is of show quality, that length of ear will not be so large a factor as it was in the case of this study when the ears were field run, varying from less than five inches to more than ten inches in length. It would be interesting to make another study to determine just what is in the minds of the corn judges when they are judging single ear samples at a corn show.

That corn judging is to some extent a profession with recognized standards is indicated by the fact that the correlation coefficient between the scores of different judges working on the same 500 ears of field run corn averaged around .7. Inasmuch as corn judging still has a vogue in some of our Corn Belt states, it would seem to be worth while to determine just what is in different corn judges' minds. It would be especially interesting to have corn judges from central Iowa, central Illinois, and central Indiana work on the same 500 ears and then make up by means of path coefficients their true score cards.