Journal of the American Society of Agronomy, 1923, *15*, 300–304.

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

H. A. WALLACE

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.

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

[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.

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:

$$.7 = b + .3c + .3d + .2e + .2f + .2g$$
$$.4 = .3b + c + .2d + .1e + .0f + .0g$$
$$.5 = .3b + .2c + d + .4e + .2f + .2g$$
$$.4 = .2b + .1c + .4d + e + .5f + .6g$$
$$.2 = .2b + .0c + .2d + .5e + f + .5g$$
$$.3 = .2b + .0c + .2d + .6e + .5f + g$$

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 worthwhile 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.

Henry Wallace and statistics by Oscar Kempthorne

The story on Henry Wallace is not complete without reference to his contributions to plant breeding, genetics, and statistics. While Henry A. was a student at Iowa State University, he began a series of experiments on the home farm designed to determine whether methods then advocated for selecting seed corn really had anything to offer. He had studied plant breeding at Iowa State, which fueled his skepticism concerning existing dogma, and he wanted to put his knowledge to the test. This involved experiments and analysis of resultant data. And so began his interest in statistics.

While Henry A. was experimenting with corn breeding, he became interested in the relationship between the amount of corn produced nationally and its price. Wallace recalled later that he ran across the work of H.L. Moore from Columbia University in about 1913. After he had devoured Moore's work and methods, Wallace worked on his own in the analysis of agricultural prices, depending heavily on regression and correlation analysis. In 1920, he published the book *Agricultural Prices*, in which he makes generous use of the knowledge of statistics he had by then acquired.

Wallace wanted the faculty at ISU to know about the methods he had been using and was convinced that staff members were not sufficiently current in statistics. He met with several professors and, in his own words, "sold them on the idea that they should be able to evaluate their experimental work much more adequately if they had some adequate statistical background."

No shrinking violet, Wallace arranged to be invited to organize a class and to present these new methods to members of the Iowa State staff in the spring of 1924. He was helped by C.F. Sarle, who later became a leader in meteorology.

Wallace was concerned about the computational drudgery involved in statistics, especially in correlation analysis, so Sarle and Wallace arranged to borrow equipment from an insurance company in Des Moines, which they hauled back and forth to Ames on Saturday mornings during the spring of 1924. A young staff member in Ames, George Snedecor, helped Wallace with this teaching project, and together they produced the research bulletin *Correlation and Machine Calculation*. In this bulletin, reference was made to Truman Kelley, R A. Pearl, H. L. Rietz, H. R. Tolley, and M. J. B. Ezekiel, leading statisticians of the 20s and earlier. All of this activity at Iowa State led to the organization of the Mathematical Statistical Service in 1927 and the formation of the Statistical Laboratory in 1933; and brought R.A. Fisher from England to Ames in 1930. In Wallace's view, the strong impetus Fisher gave the program was a major factor contributing to its remarkable reputation.

Henry A.'s diverse interests were a contributing factor in his success and to the success of many ventures in which he was involved. His interest in genetics and statistics led to the start of the Iowa State Corn Yield Test and to the founding of the Pioneer Hi-Bred Corn Company, now the biggest in the world. He was regarded in the United States as the father of soil conservation, of rural electrification, the use of weather forecasting and of economic agricultural statistics. He was secretary of agriculture (1933-40); chairman of the Board of Economic Warfare (1941-45); vice president of the United States (1941-45); secretary of commerce (1945-46); editor of the New Republic (1946-47). He took an active interest in the Bureau of Agricultural Economics, which affected the growth of the Statistical Laboratory at Iowa State University and led to a huge sampling effort to obtain a reliable picture of the status of agriculture throughout the United States.

Until his death, Wallace continued to take an interest in the Statistical Laboratory, which has honored him by naming the seminar room as the "Henry A. Wallace Room," and in which his portrait is proudly displayed.

Oscar Kempthorne is a professor emeritus, Department of Statistics, Iowa State University

---

Henry A. Wallace and the Modeling of Expert Judgments (From *A Statistical Guide for the Ethically Perplexed*, Lawrence Hubert and Howard Wainer, 2013, pp. 146–150).

There are several historical connections between Henry A. Wallace, one of Franklin D. Roosevelt's vice presidents (1940–1944), and the formal (paramorphic) modeling of the prediction of experts, and applied statistics more generally. Wallace wrote an article (1923) in the *Journal of the American Society of Agronomy* (*15*, 300–304) entitled "What Is In the Corn Judge's Mind?" The data used in this study were ratings of possible yield for some 500 ears of corn from a number of experienced corn judges. In addition to the ratings, measurements were taken on each ear of corn over six variables: length of ear, circumference of ear, weight of kernel, filling of the kernel at the tip (of the kernel), blistering of kernel, and starchiness. Also, because all the ears were planted in 1916, one ear to a row, the actual yields for the ears were available as well.

The method of analysis for modeling both the expert judgments of yield and actual yield was through the new method of path coefficients just developed by Sewall Wright in 1921 ("Correlation and Causation," *Journal of Agricultural Research*, *20*, 557–585). The results were final "scorecards" for how the judges and the actual yield values could be assessed by the six factors (each was normalized to a total of 100 "points"):

JUDGES' SCORE CARD:
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

ACTUAL YIELD SCORE CARD:
Length – 7.7
Circumference – 10.0
Weight of kernel – 50.0
Filling of kernel at tip – 18.0
Blistering of kernel – 9.0
Absence of starchiness – 5.3
Total – 100.00

In rather understated conclusions, Wallace comments:

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. (p. 302)

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 samples 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 should 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 worthwhile 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. (pp. 303–304)

In addition to a political career, Wallace had a life-long and avid interest in statistical computing. We give an essay by David Alan Grier, *The Origins of Statistical Computing*, posted on the American Statistical Association website:

The lab in the Department of Agriculture inspired two Iowans, George Snedecor and Henry A. Wallace, to experiment with punched-card statistical computations. Henry Wallace eventually rose to prominence as the Vice President of the United States, but during the 1920s, he was the publisher of his family's farm journal, *Wallaces' Farmer*. He was also a self-taught statistician and was interested in the interplay of biology and economics in farm management. During the 1910s, he learned the methods of correlation studies and least squares regression by reading Yule's book, *An Introduction to the Theory of Statistics* (London: Griffin, 1911). Finding in that book no easy method for solving the normal equations for regression, Wallace devised his own, using an idea that Gauss had applied to an astronomical problem.

In 1923, Henry A. Wallace learned of the new statistics lab at the Department of Agriculture while he was visiting his father, Harry Wallace, who was then the Secretary of Agriculture. Intrigued with the machines, he borrowed a tabulator at a Des Moines insurance firm and taught himself how to use the device to calculate correlations.. He would punch data cards and would then take them to the offices of the insurance company for tabulating. During the first years of the 1920s, he published ever more sophisticated statistical studies in the pages of *Wallaces' Farmer*, studies that must have baffled many of his loyal readers, who tended to be modestly educated farmers. The last, published in January 1923, was a detailed study of land values in the state.

The study of Iowa land values marked the maturity of Wallace's statistical ability. By the time he published it, Wallace had become a friend of

George Snedecor, who taught the statistics courses at Wallace's alma mater, then named Iowa State College. Impressed with Wallace's knowledge of least squares, Snedecor invited him to teach an advanced course on those methods to college faculty. This class, which met for 10 consecutive Saturdays over the fall and winter of 1924, ended with a demonstration of punched-card calculation. After the class, Snedecor helped Wallace prepare a manuscript on his algorithm for solving normal equations. They jointly published the manuscript in 1925 with the title "Correlation and Machine Calculation."

The title of Wallace's and Snedecor's pamphlet tends to mislead modern readers. For the most part, the machines to which it refers are desk calculators, not tabulating machinery. Part of Wallace's methods were easily adapted to tabulating machines. By computing sums of squares and sums of cross-products, a mechanical tabulator could quickly produce a set of normal equations. The same tabulator, however, could not be easily used to solve these equations. It was extremely awkward, if not impossible, to use a 1920s vintage tabulator to solve matrix arithmetic problems. Such problems were solved by human computers who used desk calculators.

Inspired by Wallace, Snedecor devoted much effort to acquiring tabulating machines for his university. He was able to secure them in the Fall of 1927 and established a statistical computing lab within the Department of Mathematics. This first lab seems to have been a cooperative effort by several college departments and may have been partly supported by local IBM officials, who were interested in placing their equipment at universities. IBM helped many schools establish computing labs at that time. The first was at Cornell, which leased tabulating machines to form a lab in 1926. Next came Iowa State College, Columbia University, and the University of Michigan, who acquired these machines in 1927. Shortly thereafter came the University of Texas, Harvard University, Stanford University, and the University of Tennessee

———

```
>> type corn_script

rater_vector = [.7;.4;.5;.4;.2;.3]
yield_vector = [.2;.15;.4;.3;.2;.2]
```

```
intercorr = [ 1.0 .3 .3 .2 .2 .2; .3 1.0 .2 .1 .0 .0; ...
    .3 .2 1.0 .4 .2 .2; .2 .1 .4 1.0 .5 .6; .2 .0 .2 .5 1.0 .5; ...
    .2 .0 .2 .6 .5 1.0 ]

beta_rater = inv(intercorr)* rater_vector

beta_rater_abs = abs(beta_rater)

sum_beta_rater = sum(beta_rater_abs)

prop_beta_rater = (beta_rater_abs) ./ (sum_beta_rater)

beta_yield = inv(intercorr)* yield_vector

beta_yield_abs = abs(beta_yield)

sum_beta_yield = sum(beta_yield_abs)

prop_beta_yield = (beta_yield_abs) ./ (sum_beta_yield)

rsquared_rater = (rater_vector')*beta_rater

rsquared_yield = (yield_vector')*beta_yield
```

```
>> corn_script

rater_vector =

    0.7000
    0.4000
    0.5000
    0.4000
    0.2000
    0.3000


yield_vector =

    0.2000
    0.1500
    0.4000
    0.3000
    0.2000
```

```
    0.2000


intercorr =

    1.0000    0.3000    0.3000    0.2000    0.2000    0.2000
    0.3000    1.0000    0.2000    0.1000         0         0
    0.3000    0.2000    1.0000    0.4000    0.2000    0.2000
    0.2000    0.1000    0.4000    1.0000    0.5000    0.6000
    0.2000         0    0.2000    0.5000    1.0000    0.5000
    0.2000         0    0.2000    0.6000    0.5000    1.0000


beta_rater =

    0.5437
    0.1730
    0.2334
    0.1726
   -0.0830
    0.0825


beta_rater_abs =

    0.5437
    0.1730
    0.2334
    0.1726
    0.0830
    0.0825


sum_beta_rater =

    1.2881


prop_beta_rater =

    0.4221
    0.1343
    0.1812
    0.1340
    0.0644
```

```
    0.0641


beta_yield =

    0.0480
    0.0623
    0.3105
    0.1123
    0.0556
    0.0331


beta_yield_abs =

    0.0480
    0.0623
    0.3105
    0.1123
    0.0556
    0.0331


sum_beta_yield =

    0.6218


prop_beta_yield =

    0.0771
    0.1002
    0.4994
    0.1806
    0.0894
    0.0533


rsquared_rater =

    0.6436


rsquared_yield =
```

```
0.1946
```

From *Correlation and Machine Calculation*, Wallace and Snedecor, Part VI: Precautions and Suggestions (1925, pp. 46–47)

Before any correlation study is undertaken, it is important to make a serious effort to think through the nature of the causes connecting the variables. Much valuable time and effort are wasted by rushing into elaborate calculations before a definite plan is formulated. Many students, laboriously working out correlation coefficients, feel that their work must have a certain virtue simply because they have spent so much time in calculation. On the other hand, preliminary correlation studies are often indispensable as a guide to the formulation of the final plans even though the latter may not include the correlation methods at all

Cause and effect cannot be determined by correlation. Two variables may be constantly and intimately associated and yet have no causal relations whatever. The correlation coefficients merely point the way to further study and investigation.

Utter familiarity with the data is a prerequisite to successful deductions. Correlation is not a magic formula. Mere calculation, no matter how intricate or extensive, can never take the place of intimate, "common sense" knowledge of the records. Only the man who has worked over his material from many angles until he has become thoroughly familiar with it can hope to apply correlation coefficients and regression lines in a truly fruitful way.

There is a tendency to look upon correlation coefficients as an end in themselves. In some cases, the mechanical labor absorbs so much energy and time that there is very little left for the real job of interpretation. In reality, the correlation coefficients and related constants are usually just a beginning in any serious study. Unless hard thinking and common sense are used in interpretation, correlation work may do more harm than good.

Two extremes should be avoided in your attitude toward the correlation results. On the one hand do not be discouraged if the correlation coefficient is lower than expected, or if the estimated values of the criterion vary widely from actual. Study with the greatest care the cases which deviate most widely. Are they due to accidental or unusual circumstances, and can such be avoided? Should the relationship be expressed by a curved regression line rather than by one which is straight? Is it necessary to include other variables to account for the discrepancies? Remember, it is not impossible that important discoveries can be initiated by first learning that expected correlation does not really exist. On the other hand, do not be too easily satisfied. It would be a shortsighted policy to stop with a correlation coefficient of .96 when a more perfect explanation might be readily apparent after a little further work.

If the number of independent variables is large and the number of observations relatively small, the multiple correlation coefficient seems to gather a certain amount of "fictitious correlation" merely from the multiplication of the number of variables. B.B. Smith has a correction formula to be used in such cases. This is expected to appear in the March, 1925, issue of the Journal of the American Statistical Society.

The formula is Corrected $R^2 = 1 - (1 - R^2)/(1 - (M/N))$, where M is the number of independent variables and N is the number of observations.

What is the real object of correlation coefficients and their related concepts? The details vary with the field of investigation, with the particular problem in hand, and with the mental peculiarities of the investigator. The purely scientific effort to determine causal relations, the prediction of market prices, vocational guidance, educational policies, the correct method of scoring corn, heredity, land values, the correction of yields for soil variation—these are some of the problems attacked with correlation methods. The research worker must always interpret his results in the light of his own knowledge. After all, correlation is simply one scheme for discovering and evaluating relationship.

Excerpt from H.A. David, *Statistics in U.S. Universities in 1933 and the Establishment of the Statistical Laboratory at Iowa State*, *Statistical Science*, 1998, *13*, 66–74.

No doubt, these early years were an important learning period for Snedecor, preparing him to profit from the stimulus and boost provided by a series of 10 Saturday afternoon lectures given, in the winter or spring of 1924, by Henry A. Wallace. Wallace was to become the New Deal Secretary of Agriculture (1933-1940), Vice President in Franklin D. Roosevelt's third term (1940-1943), Secretary of Commerce to Harry S. Truman (1946) and Progressive Party Presidential Candidate in 1948. Born into a distinguished Iowa family, he was a 1910 graduate in agriculture from Iowa State, and class valedictorian. In 1921 he had become editor of *Wallaces' Farmer* in Des Moines, following the appointment of his father, Henry C., as Secretary of Agriculture. Thus H.A. had easy access to the experts at the Bureau of Agricultural Economics, an agency set up by his father.

From boyhood Wallace had been experimenting with the crossing of plants, especially corn, and in 1926 he founded the still very successful Pioneer Hi-Bred Corn Company. Coupled with this activity was a keen interest in a statistical study of the factors influencing corn yields. Later (Wallace, 1951) he reminisced:

My work on cycles began in about 1913, when I began to study the relationship of weather to corn yields, of corn supply to corn prices, the relation of corn prices to hog prices, the cycle of hogs, the cycle of cattle, the cycle of horses, and so on. I did that as a preliminary to getting into more serious and careful statistical work. As a result of studying the relationship of corn weather to corn yields, I ran across the work of H.L. Moore, the Columbia University professor. He had put out some very careful statistical analyses involving the relation of independent variables to a dependent variable, expressing them by regression lines and correlation coefficients. Suffice it to say that I became proficient at doing work of that kind, using a key-driven calculating machine to facilitate matters. I thought that the people at the Iowa State College of Agriculture and Mechanical Arts at Ames were not sufficiently current in that field. I went up and met with several of the professors and sold them on the idea that they should be able to evaluate their experimental work much more accurately if they had more adequate statistical background. As a result, they employed me for ten weeks to conduct a statistical course ... There was no one in the class of some twenty who was not either a professor or a post-graduate student.

I suppose the last sentence reflects some justifiable pride by one who stopped with a B.S. After describing the first warming-up problem of the course, Wallace continues:

Then I took another problem which was interesting to them as agricultural people–the relationship between farm land values in the different counties–for which there were census figures–and the yield of corn per acre. We used an average of ten years for which we had crop reporting figures. We used the percentage of the crop land in corn, for which we had census figures; the value of the buildings per acre, for which we had census figures; and so on. We took up various independent variables bearing on the dependent variable of the value of the farm land per acre. That was the problem which I set to them, which later was embodied in a bulletin put out by Iowa State College entitled *Correlation and Machine Calculation*.

Wallace wrote the first draft of the bulletin. Snedecor, the statistician in the audience of mainly agricultural and biological research workers, put the material in final shape to produce a publication of just 47 pages (Wallace and Snedecor, 1925) that reached worldwide circulation. From subsequent correspondence and statements it is clear that Wallace remained proud of his important early role in fostering statistics at Iowa State.

Spurred on, George Snedecor according to the 1925-1926 Iowa State catalogue expanded BM (Biometric Methods of Interpreting Agricultural Data) to two 3-credit courses, the second described as "Multiple Correlation and Machine Calculation"; a third quarter was added in 1927-1928. Snedecor also offered a 3-credit biomathematics course.

The bulletin, Snedecor's first publication, at the age of 42, apparently set free his pen, both for research papers and expository articles and books. His *Statistical Methods*, first published in 1937, later coauthored by W.G. Cochran and now in its eighth edition, was a phenomenal success. The text has nearly 2,000 entries in the Science Citation Index for 1995. More immediately following the bulletin came a series of papers, single-authored, or jointly authored with agricultural colleagues. A.E. Brandt, soon to become Snedecor's right-hand man, entered the scene during these years and contributed significantly to statistical and computational research. In 1926 Brandt wrote a M.S. thesis and in 1932 a Ph.D. dissertation, both under the Iowa State geneticist D.W. Lindstrom. The thesis, which was quite statistical, already followed closely "the methods of the bulletin." Brandt was particularly skilled in computational methods.

A preliminary step in the creation of the Statistical Laboratory was now taken by the newly appointed President of the College and the Head of the Mathematics Department. In a 1940 Iowa State College Bulletin featuring the Statistical Laboratory we read:

The Department of Mathematics of Iowa State College is noted for its willing and effective cooperation with people having problems in applied mathematics. In statistical applications Professor Snedecor took the lead shortly after joining the staff in 1913. Following the lectures of Dr. Wallace, the demand for professional help in statistics grew so rapidly that in 1927 President R.A. Hughes and Professor Smith instituted the Mathematics Statistical Service with Professor Snedecor and Dr. A.E. Brandt in charge. Calculating and punched card tabulating equipment was installed ...

Activities clearly intensified. In 1928 Brandt published three articles with a computational emphasis and Snedecor wrote on the uses of punched card equipment ... Snedecor's student, Gertrude Cox, made her first publishing appearance in 1930, and in 1931 completed the first M.S. thesis in statistics at Iowa State, through the Mathematics Department. Also, Snedecor made a major revision of the bulletin (Wallace and Snedecor, 1931) incorporating "some of the elegant methods devised by Dr. R.A. Fisher for testing the significance of the various correlation statistics." He was finally promoted to full professor.

...

Although Hotelling was then rightly regarded as the primary exponent in the United States of the new Fisherian approach, Snedecor was among the first in this country to recognize the extreme importance of Fisher's statistical methods. Moreover, he was able to arrange a six-week visit by Fisher in the summer of 1931. This was made possible by an enlightened Graduate College program that each summer brought in a distinguished lecturer whose work was of interest to several departments ... Fisher gave three lectures a week based on *Statistical Methods for Research Workers* and three more on either the theory of statistics or *The Genetical Theory of Natural Selection.* He was also active in the discussion of experimental work by the local staff. The visit was a great success and no doubt boosted the standing of statistics as a discipline at Iowa State. Fisher paid a return visit in 1936, at which time he was awarded an honorary D.Sc., his first.

The final element important in the establishment of the Statistical Laboratory was Iowa State President Hughes's emphasis on the administrative efficiency to be gained by centralization, especially in a time of economic stringency. The way this affected statistical activities can be clearly seen from annual Reports of the President to the Faculty, available in the Department of Special Collections, Iowa State Library ... On September 17, 1930, he wrote:

For some years the College has been fortunate in having a Hollerith machine available for use by any department ... Recently a plan has been worked out for the operation of the machine by the clerical staff of the Agricultural Economics Section, which uses it largely ... I hope all departments using statistical methods will inform themselves fully of these facilities and use them wherever possible in preference to setting up separate statistical organizations.

By September 16, 1931, President Hughes had decided to pass the authority for computing on to George Snedecor:

The computing facilities of the college have been unified under the control of the mathematics statistical service, cooperating with the Agricultural Economics computing department. This makes possible a uniform policy, covering not only adding and computing machines, but also the Hollerith tabulating equipment ... All new computing machines bought hereafter by the college will be purchased on the requisition of Professor Snedecor. He will also repair or replace all worn-out machines. We now have over 100 of these expensive machines in use on the campus and it is only through a central director in full charge of all of them that we can insure their economical use ...

Clearly, the use of statistics had become an important element in the college's growing research program. In 1932, Iowa State ranked 13th among the nation's universities in the number of Ph.D. degrees awarded ...

The effect of the Depression on the college, such as reduced enrollment and reductions in salary, is clearly acknowledged in the Report for September 21, 1932. No reference is made to statistics, but the Statistical Laboratory is born on July 1, 1933, as an institute under the President's office, with George W. Snedecor as Director. The laboratory's functions are described in the College Catalogue for 1934-1935 under five headings: Research; Statistical Counsel; Teaching; Computation Service; and Calculating Machines. It is explained that the laboratory is not a department of instruction, but that members of its staff devote part of their time to teaching statistics in the Mathematics Department. Snedecor, Brandt, and Cox were the initial faculty members of the Statistical Laboratory. Their teaching on the theory side was supplemented by other members of the Mathematics Department.

This completes our story. As a brief epilogue we may note that the teaching arrangement continued even when the laboratory staff was substantially increased as a result of a cooperative agreement in 1938 with the U.S. Department of Agriculture. A key appointment was that of W.G. Cochran, who soon took the initiative in setting up a Ph.D. program. Courses and research activities now multiplied. The laboratory had frequent visitors interested in establishing similar statistics programs ... However, a department was not formed until 1947 when Snedecor had reached mandatory retirement age as Director and all the other individuals mentioned here had departed.

From John C. Culver and John Hyde, *American Dreamer: A Life of Henry A. Wallace*, 2000, pp. 26–29:

For centuries, beginning with the ancient Incas, corn farmers used a simple process of visual selection to perpetuate their crops. The farmer would decide which ears of corn looked best to him and set them aside as seed for the next year's crop. Over time this process obliterated "wild corn" and resulted, especially throughout the Midwest, in a certain uniformity of characteristics. Particularly popular around the turn of the century was a variety known as Reid yellow dent, which produced long, good-looking cylindrical ears covered from tip to butt with arrow-straight rows of kernels.

Reid yellow dent won a blue ribbon at the Chicago World's Fair in 1893 and quickly became the midwestern ideal. Agricultural organizations and institutions began sponsoring "corn shows," at which ears of corn were judged competitively according to their appearance.

Elaborate "show ring" standards were devised, and the judging of corn became a fine art. A perfect ear of corn was deemed to be 10 1/2 inches long and 7 1/2 inches in circumference. It should have twenty or twenty-two straight rows of plump, wide, keystone-shaped kernels that bore no evidence of shrinkage or blistering. The standards were based on bogus science, but they were no less important for that. The lucky farmer who won a corn show competition was rewarded amply with prestige and money. Hundreds of dollars were paid for winning ears.

At the edge of the corn show circus were a few nonbelievers: some skeptical old-fashioned dirt farmers, a handful of agricultural scientists who understood the great flaw in the visual selection process, and one shy high school boy in Des Moines named Henry A. Wallace.

The Young Henry would have doubts about corn shows was all the more remarkable because by 1902 his family was heavily engaged in promoting them. A corn contest organized by *Wallaces' Farmer*, open to any farm boy who could obtain three new subscriptions to the paper, drew entries from across the country. Hundreds gathered in the farm journal's lobby to witness the judging.

Moreover, the Wallaces had succeeded in attracting to Iowa one Perry G. Holden to help promote the corn shows. No more fabulous character ever strode across the Corn Belt than this slight, bearded man with steel-rimmed spectacles. Part teacher, part salesman, part businessman–and all showman–Holden was known as the Corn Professor, the Evangelist of Corn, and the nation's leading exponent of lovely looking Reid yellow dent. With Uncle Henry's help, Holden spread his message at corn shows, aboard special "corn trains" sponsored by *Wallaces' Farmer*, and through a professorship at Iowa State partly subsidized by the Wallace family. "No man ever engaged in more rapid and effective mass education of farmers than did P.G. Holden from 1902 to 1910 in Iowa," Henry A. Wallace later wrote.

Young Henry rather liked the Corn Professor, at lest the part of Holden that was more scientist than huckster. Holden first won the boy's heart by siding with him on a question of agricultural practice. Henry had been quarreling with his father over the proper way of fertilizing a tree. Put ashes in a ring around the tree's base ... Harry insisted. No, the boy said, put ashes in a ring six feet from the tree's based so as to be closer to the tips of its roots. Holden sided with Young Henry, which pleased him greatly. It was the first time he had won an argument with his father.

In January 1904 Holden offered one of his short courses for farmers at Iowa State, and the fifteen-year-old Henry Wallace decided to attend. For two weeks he watched Holden preach the message of good farming and better living through beautifully shaped ears of Reid yellow dent. Hour after hour Holden expounded upon the proper aesthetic standard for the judgment of corn.

Most of Holden's students were completely persuaded by the professor's passion and sincerity. But to Young Henry the message didn't ring true. What did aesthetic standards have to do with yield? What did it matter that some variety of corn was said to be a "pure" breed or displayed "good constitution"?

At the end of a lecture, the boy decided to make his doubts known. "What's looks to a hog?" he asked. A corn farmer's goal ought to be big yields. It was remarkable, a reserved teenage challenging an eminent expert on the very grounds of his expertise. It was also typical. From an early age, and for the remainder of his life, a central characteristic of Henry A. Wallace's personality was independence of mind. He was open to any idea, however silly sounding, until he could test its validity. He was prepared to reject any idea, no matter how broadly accepted, that would not stand the weight of inquiry.

And he was–this was another of those traits that frequently made people uncomfortable around Henry A. Wallace–altogether unsentimental in making intellectual judgments. That Holden was a well-meaning man who had done farmers great good was beside the point. That almost everyone who heard him accepted his teachings was irrelevant. That he was close to Uncle Henry and Harry Wallace and had befriended young Henry mattered not. If Holden was wrong, he should be proven wrong.

Holden, of course, confidently reasserted his belief that good appearance reflected good quality. In any event, the professor said, Young Henry could easily test the theory for himself. Holden gave the boy several ears of corn on display and told him to use them for seed. The truth would reveal itself; the finest-looking corn would produce the biggest yield and the worst-looking corn the smallest.

Young Henry accepted the challenge on the spot. He returned to Des Moines with a bag of thirty-three ears of Reid yellow dent corn and prepared to put them to the test. In the spring he persuaded his father to let him use five acres of land behind their home. He numbered, labeled, and shelled each ear of corn. The seed from each ear he planted in two rows. All summer he walked through his sixty-six rows of corn, fertilizing and thinning, cultivating and weeding.

He did more. In order to eliminate the possibility of self-fertilization, which would reduce yields, he decided to detassel half his crop. That is, he cut off the corn plant's male sex element, the tassel, so it could not reproduce with itself. Cutting off the tassel is a simple task–a quick slice of a knife, and the tassel is gone–but detasseling a field of five acres was arduous work. For several weeks each row had to be constantly patrolled so that the detasseling could be done at precisely the right moment.

In the fall Young Henry harvested his crop, husked the ears, and stored them in thirty-three neatly numbered piles on his father's garage. He had only to wait for the corn to dry so that it could be shelled and weighed. He stared at the piles for days, aching to know their secret, and finally decided he could wait no longer. He calculated the percentage of an ear composed of cob and estimated the amount of weight loss through drying. This he could verify when the corn had actually dried. Ever a math buff, he devised a ratio of whole, fresh-picked ear to dried shelled corn.

In the evening, after his chores were done, this "too-solemn boy" sat in the garage, weighing and calculating, filling up sheet after sheet of paper with row upon row of numbers and contemplating the astounding results.

He had ruined the Corn Professor. His experiment demonstrated beyond question that corn shows and show-ring standards and grand-champion corn auctions were a ridiculous waste of time and money. It was right there in his figures. The ears of fine yellow dent corn Holden had given him ranged in yield from thirty-three to seventy-nine bushels an acre. Some of the best-yielding ears were those Holden had judged to be the poorest. And the ear that Holden had singled out as the most beautiful of all was one of the ten worst in yield.

Holden continued to be a celebrity in Iowa, and corn shows remained popular for years. But the beginning of their decline was there in Harry Wallace's garage, in the hands of a teenage boy armed with a soft-lead pencil. Henry A. Wallace would become the most outspoken opponent of corn shows in the Midwest, relentlessly mocking the pseudo-science on which they were based. By the 1920s the corn shows were little more than a colorful relic of the past; in thir place were scientifically conducted yield contests, devised by Wallace and his allies as a more appropriate means of judging agricultural excellence.

"Fortunately, a few farmers never 'took any stock' in Holden or Reid corn," Wallace wrote years later. "These mavericks went their own way, and a few, a very few, of their corns have been preserved. Holden rendered an enormous service, but we can also give thanks for the skeptics and the 'forgotten corns.'

There is room for both 'forgotten corn' and 'forgotten men." Neither corn nor men were meant to be completely uniform."

Corn and Its Early Fathers (Henry A. Wallace and William L. Brown; 1956 and 1988); Chapter 14: Small Gardens and Big Ideas

From the time of James Logan's experiments with corn in 1727 until the time of East and Shull in the early 1900s, a great part of the best work in corn breeding was done by persons using a few plants and small areas of land. Logan's garden was forty by eight feet; it contained only four hills of corn. But Logan, by clear and hard thinking in advance, made these four hills of corn tell him in a more precise way than had ever been done before, the fundamental facts of sex in the corn plant.

After Mendel entered the Augustinian Monastery he had assigned to him a garden about fifteen feet wide and thirty or forty feet long, with one side against the monastery wall. Out of this small garden planted with peas, Mendel derived the celebrated law which he described in his 1865 paper, first presented before the Brünn Society of Natural Science and later published.

When George Shull began work at Cold Spring Harbor, on the north shore of Long Island, he had available for all of his experimental plantings not more than one acre of land. Only a part of this was used for corn, for Shull was also working with other kinds of plants. It is unlikely that in any one year more than one quarter acre was devoted by him to the growing of corn. Yet, with his relatively few plants, Shull was able to establish practically all of the principles and many of the methods upon which modern corn breeding still depends.

When E.M. East arrived at the Connecticut Experiment Station, little experimental ground was available to him; he therefore found it necessary to rent from farmers small areas on which to continue his inbreeding and make his crosses. But despite his lack of large areas of land and large numbers of plants he, like Shull, soon arrived at a series of fundamental facts which revolutionized corn improvement and are applicable even today. East evidently remained a firm believer in the value of careful intensive study of a small sample of critically selected plants. In later years, at the Bussey Institution of Harvard University, he frequently advised his students to discard much of their material in order to concentrate on the remainder. In private conversations with his students he would refer scornfully to those students of corn who grew so much material "they didn't know what they had."

When the senior author began inbreeding corn in 1913, he had only a fraction of an acre with the city limits of Des Moines on which to work. An inbred corn capable of unusually high yield came out of his backyard garden, which was but ten by twenty feet.

No doubt there are dozens of plant breeders who can point to the fact that when they were living very close to their plants, seeing them every day, and spreading attention thickly over a small area, they got many times greater a return per hundred square feet than they did when working with large numbers of plants covering acres of land. Yet, even today, there are a surprising number of plant breeders who fail to recognize and appreciate this fact.

The modern trend in science is in exactly the opposite direction. The present emphasis is directed toward doing things in a big way, toward the use of large numbers and multidisciplinary research. In many of our educational institutions, scientific progress seems to be measured in terms of the growth of departments and the number and size of financial grants that can be obtained for support of the work. And even corn breeding, it appears, has not entirely escaped this emphasis. Today's trend is toward the use of large areas of land and, in many cases, routine types of investigation and thought. The work accomplished is often measured in terms of budget size, of the numbers of pollinating bags used, or the numbers of acres devoted to yield testing. This may be an expression of the Burbank idea that the thing to do is to grow immense numbers of plants in the hope of getting just one lucky recombination or mutation.

Others say that the current approach of using large numbers is based on the science of statistics. We do not question the proper use of statistics in breeding. Corn breeding has advanced to the point at which it is not longer satisfactory to rely upon simple observation as a measure of one's progress. Marked improvements in characteristics selected-for are no longer easy to obtain, and, as a result, refined measurement is usually necessary to detect real differences. Yet we feel that nothing can replace the value to a breeder of careful study and understanding of his plants–study of a type advocated and so successfully practiced by Dr. Beal. More and more, we feel that grave danger exists of statistics being used as a substitute for critical observation and thought.

The senior author joins somewhat apologetically in presenting this point of view because he had a lot to do, back in 1923, with starting the present Statistical Laboratory in Iowa State College, one of the better departments of its kind in the nation. Statistics have their place, a very important one, but they can never serve as a substitute for close association with plants. Their real value, it seems to us, is in measuring precisely what we already know in a general way. Statistics tends to be an office art based on machines and figures rather than a field art based on living things. Careful record keeping is certainly important in any scientific work. Yet East himself was so immersed in his corn plants and so wrapped up in everything he was doing that he tended to keep his notes on used envelopes and to substitute his memory for carefully kept records. This idiosyncrasy was perhaps a weakness on East's part. It reflected something profoundly worthwhile in East. He apparently operated on the premise that one's first job in botanical research was to determine the biological significance of what appeared to be happening in his experiments. He drilled his students in the principle of "the significant figure" and was impatient with those who could not take it in.

Refined tests for yield and performance have, of necessity, become of prime importance in modern corn breeding. There is certainly no question as to the necessity of the yield test in a breeding program, yet we wonder if it does not at times become an end in itself. To set up a large testing program, depending upon relatively untrained help to collect the data and measuring one's progress by the volume of data thus amassed, has been made easy by the computer. The ever-increasing size of the yield test makes it humanly impossible for the breeder adequately to study in the field the performance of all his crosses.

A great deal of work has gone into the development of mathematical models designed to explain just how hybrid vigor operates. As a mode of attack, we believe, it overlooks completely the more important problem of understanding the specific ways in which hybrid vigor affects the plant itself. We fear that until we return to thinking of corn in terms of what the plant itself is doing, instead of working out neat mathematical formulae to fit what we think its performance should be, no real advance will be made.

Perhaps we, as corn breeders, could well take a lesson from George Washington Carver, whose approach to problems in science appeals to us as one of great merit. The senior author talked many times with George Carver, beginning in 1894, and as a result of these talks feels that he gained a real insight into Carver's motivating philosophy. Carver's search for new truth, both as botanist and chemist, was a three-pronged approach involving himself, his problem, and his Maker. He earnestly believed that God was in every plant and rock and tree and in every human being, and that he was obligated not only to be intensely interested but to call on the God in whom he so deeply believed and felt as a creative force all around him. This attitude has something in common with that of the Hopi Indians, who believed that their thoughts and ceremonies had a direct effect upon the corn plants with which they worked. There is, of course, no scientific way of proving Carver or the Hopi Indians right or wrong. But we can safely say that if a corn breeder has a real love for his plants and stays close to them in the field, his net result, in the long run, may be a scientific triumph, the course of which will never be revealed in any statistical array of tables and cold figures.

The great scientific weakness of America today is that she tends to emphasize quantity at the expense of quality–statistics instead of genuine insight–immediate utilitarian application instead of genuine thought about fundamentals. The American approach has performed miracles in utilizing our great resources in record-breaking time. We have become the best exploiters in the world, but in many fields we have not always become the best researchers. Europeans did most of the basic work in atomic physics. We used our wealth, our power, our mechanical ingenuity, to put to work what the Europeans had discovered. As early as 1955, the Netherlanders had already developed some of the best types of machinery for the peacetime utilization of atomic power.

Although, as someone has suggested, there may be a high negative correlation between research and resources, big ideas do not always and inevitably go hand in hand with slender resources in the scientific world. The point we are making in that lots of land, equipment, and power can never produce scientific advancement in corn breeding or anything else unless the ideas are big enough to match. And, unfortunately, when the equipment, land, and manpower pass a certain point of immensity, the men who are supposed to do the scientific thinking tend to become mere administrators, making the wheels go around, keeping records, compiling data, conducting meetings, and appointing committees, but not thinking often enough or hard enough about the next fundamental step forward.

We believe that true science cannot be evolved by mass-production methods. We are appealing to the spirit that caused James Logan, W.J. Beal, E.M. East, and George Shull to do their work with little money, land, and equipment. It was right that this work should be followed by men who had resources to do things in a big way–these last were making roads where the trail had already been blazed. We are saying that there is still a great and glorious opportunity for *trailblazers* as well as *roadmakers* in 1988.

Who Was Henry A. Wallace?

The Story of a Perplexing and Indomitably Naive Public Servant

AMERICAN DREAMER: The Life and Times of Henry A. Wallace; By John C. Culver and John Hyde; W.W. Norton (2000).

March 12, 2000 — ARTHUR SCHLESINGER JR. — Arthur Schlesinger Jr. is the author of many books, including three volumes of "The Age of Roosevelt." He served as special assistant to President John F. Kennedy and is working on his memoirs.

Political leaders in our democracy come in many varieties, as the present campaign suggests and as history amply records. One of the more curious examples in this century was Henry Agard Wallace of Iowa, editor, geneticist, economist, businessman, the best secretary of agriculture the country has ever had, a vice president of the United States during World War II, a third (or, as it turned out, fourth) party candidate for president at the start of the Cold War and, at the same time, an incorrigibly naive politician and privately a mystic given to improbable spiritual quests.

The oddities of Wallace's life seem to have discouraged biographers. Monographs have appeared on aspects of his career, but there has been no adequate one-volume biography. Now John Culver, a distinguished Iowa legislator who served five terms in the House of Representatives and one in the Senate, and John Hyde, a former Des Moines Register reporter, have teamed to write the life of the man they term their "state's greatest son." With unimpeded access to Wallace's diaries, his family papers, the 5,000 pages of his oral history and his thousand-page FBI file, supplemented by interviews with the vanishing group of people who actually knew Wallace, Culver and Hyde have produced in "American Dreamer" a careful, readable, sympathetic but commendably dispassionate biography.

Henry Agard Wallace came from an eminent family in the Farm Belt, a family of editors rather than of dirt farmers. His grandfather, the first Henry Wallace, began as a minister and ended as an editor, founding Wallace's Farmer, a journal dedicated to the cause of scientific agriculture and to defense of the farmer's role in the national economy. His father, Henry Cantwell Wallace, took over Wallace's Farmer and, when appointed secretary of agriculture in Warren G. Harding's administration, turned over the editorship to his son young Henry, known to friends as "H.A."

H.A. inherited a passion for the modernization of agriculture, a talent for genetics, statistics and agricultural research and a conviction that farmers, who had not shared in the fabled prosperity of the 1920s, required federal support to achieve stable incomes. He inherited also a strong religious, mystical, even messianic compulsion that undergirded his life.

The Wallaces were a relatively prosperous family. For H.A.'s 21st birthday, his father chartered a railroad car to bring the guests to a formal dinner dance at a Des Moines country club. H.A., however, was a shy young man, something of a loner, devoted to hybrid corn, econometric analysis of farm prices, the McNary-Haugen bill to raise farm income and teaching William James' "Varieties of Religious Experience" to his adult Sunday school class. When Presbyterian elders objected to James, H.A. quietly resigned from the church.

The Wallaces were also a Republican family, but in the spirit of Theodore Roosevelt, not of Herbert Hoover. H.A.'s father and Hoover, Harding's secretary of commerce, were bitter foes in the Harding cabinet. After his father died in 1924 at the age of 58, H.A. blamed Hoover for his death and opposed him for this and other reasons in the 1928 and 1932 elections. When a Democrat made the White House in 1933, Wallace was one of the two Republicans Franklin D. Roosevelt appointed to his cabinet, giving him his father's old job (the other Republican was Harold Ickes as secretary of the Interior).

Wallace was a great secretary of agriculture. In 1933 a quarter of the American people still lived on farms, and agricultural policy was a matter of high political and economic significance. Farmers had been devastated by depression. H.A.'s ambition was to restore the farmers' position in the national economy. He sought to give them the same opportunity to improve income by controlling output that business corporations already possessed. In time he widened his concern beyond commercial farming to subsistence farming and rural poverty. For the urban poor, he provided food stamps and school lunches. He instituted programs for land-use planning, soil conservation and erosion control. And always he promoted research to combat plant and animal diseases, to locate drought-resistant crops and to develop hybrid seeds in order to increase productivity.

Today, as a result of the agricultural revolution that in so many respects Wallace pioneered, fewer than 2% of Americans are employed in farm occupations–and they produce more than their grandfathers produced 70 years ago.

To Washington, H.A. remained something of a mystery. He neither smoked nor drank nor swore nor partied nor small-talked. He did not enjoy the rough-and-tumble of politics. A frugal man, he lived modestly and disdained the amenities of life. He was married to a pleasant, nonpolitical woman: No one saw them kiss, nor did anyone see them fight. Politicians found him baffling. One said, "Henry's the sort that keeps you guessing as to whether he's going to deliver a sermon or wet the bed."

Wallace had his share of controversies in the highly contentious New Deal family. But he was an evangelist for his views of democracy. "You have been doing one of the finest bits of public education that I have seen done by anybody in a very long time," Walter Lippmann wrote him in 1934. In that year alone, Culver and Hyde tell us, Wallace traveled more than 40,000 miles to all 48 states, delivered 88 speeches, signed 20 articles, published two books and met with reporters by the score. He was becoming the unofficial philosopher of the New Deal, almost the heir presumptive of FDR, a status seemingly confirmed when the president in 1940 imposed him, as his running mate, on a somewhat dubious Democratic convention.

Wallace began as vice president by removing the well-stocked bar and the well-used urinal his predecessor, John N. Garner, had installed in the vice presidential office in the Capitol. Like all vice presidents, Wallace was bored by his constitutional duty of presiding over the Senate; FDR soon gave him greater administrative responsibility than any other vice president has had, before or since. But Wallace lost bureaucratic power in a long-running feud with the tough Texan conservative Jesse Jones, the head of the Reconstruction Finance Corp., who had much more support on Capitol Hill.

In 1944 FDR sent him on a disastrous trip to East Asia. In the Soviet Union, the Russians fooled him by turning the slave labor camp at Magadan into a Potemkin village and in China, the columnist Joseph Alsop persuaded him to cable the president recommending that Gen. Joseph W. Stilwell be recalled. Wallace was really too naive for a hard world. Though he remained the favorite of labor and the liberals, FDR dumped him as his running mate in 1944 in favor of Harry S. Truman.

Wallace was, not unreasonably, bitter about the dissembling manner in which Roosevelt had handled his dismissal. He felt betrayed and, in a remarkable lapse for a man not given to earthy language, wrote in his diary about one of FDR's explanations, "I did not even think the word 'bullshit.' "

The sadness about Wallace is that few remember his serious achievements as a scientist and as a public servant. If people recall anything about him today, they think of the "Guru letters" and of the 1948 campaign, neither of which enhances Wallace's stature. Culver and Hyde deal candidly and in detail with the first and candidly, though a bit skimpily, with the second.

When Wallace left the Presbyterian Church, they write, "[f]or the next decade and a half, he explored the spiritual universe, sometimes to its outer reaches." As a young man, he had been much taken by a book called "In Tune with the Infinite" by an Emersonian popularizer named (presciently)

Ralph Waldo Trine. A divine spiritual force, Trine wrote, flows through all living things. Intuition is the means by which one subordinates individuality to the universal spirit. Wallace described himself as a "practical mystic" who believed God was in everything and that, if you went to God, you could find the answers. He was, Culver and Hyde write, an "ardent seeker of cosmic truth ... engaged upon a fantastic spiritual voyage, a quest for religious understanding that took him from the pews of mainstream Protestantism to the esoteric fringes of Eastern occultism." "Fundamentally," Wallace wrote a friend, "I am neither a corn breeder or an editor but a searcher for methods of bringing the 'inner light to outward manifestation.' "

Wallace's search for inner light took him to strange prophets. The scornful right-wing columnist Westbrook Pegler called him "a spiritual window-shopper." It was in this search that he encountered Nicholas Roerich, a Russian emigre, painter, theosophist and con man. Wallace did Roerich a number of favors, including sending him on an expedition to Central Asia presumably to collect drought-resistant grasses. In due course, H.A. became disillusioned with Roerich and turned almost viciously against him. (The account of the Roerich affair in "American Dreamer" might well be supplemented by the chapters on Roerich in the recent book "Tournament of Shadows: The Race for Empire in Central Asia and the Great Game" by Karl Meyer and Shareen Blair Brysac.)

Wallace had written Roerich and others of the cult a series of so-called "Dear Guru" letters. These letters fell into the hands of political foes and, though not used in the 1940 campaign, were brought up in 1948, when Wallace ran for president as candidate of the newly formed Progressive Party. Wallace's comments on the letters were markedly evasive and disingenuous. The 1948 campaign as a whole showed Wallace far from his best.

The onset of the Cold War had divided American liberals. Most New Dealers believed that liberalism and communism had nothing in common, either as to means or as to ends, and joined Americans for Democratic Action, a new liberal organization that excluded Communists. On the other hand, the Progressive Party represented the last hurrah of the Popular Front of the 1930s. As the radical journalist I.F. Stone wrote in 1950, "The Communists have been the dominant influence in the Progressive Party ... If it had not been for the Communists, there would have been no Progressive Party."

Wallace, in a messianic mood, saw himself as the designated savior of the republic. Naively oblivious to the Communist role in his campaign, he roundly attacked the Marshall Plan, blamed Truman for Stalin's takeover of Czechoslovakia and predicted that Truman's "bipartisan reactionary war policy" would end with American soldiers "lying in their Arctic suits in the Russian snow." The United States, Wallace said, was heading into fascism: "We recognize Hitlerite methods when we see them in our own land." He became in effect a Soviet apologist.

Wallace campaigned energetically and courageously, insisting on unsegregated audiences in the South. But he grew increasingly strident in his denunciation of the Truman administration, predicting that Truman would be "the worst defeated candidate in history." Oddly, though the success of his Pioneer Hi-Bred Corn Co. had made him a wealthy man, Wallace contributed only $1,000 to his own campaign.

In their sympathy for their subject, Culver and Hyde do not do justice to the principled objections American liberals had to Wallace's alliance with the Communists. Eleanor Roosevelt herself led the repudiation of Wallace in column after column. "The American Communists," she wrote, "will be the nucleus of Mr. Wallace's third party ... Any use of my husband's name in connection with that party is from my point of view entirely dishonest." Only one prominent New Dealer, Rexford G. Tugwell, supported Wallace, and the Communist presence led him to drop out of the Wallace campaign before its end.

"American Dreamer" does not make much of Mrs. Roosevelt's opposition nor mention Tugwell's withdrawal nor mention the statement signed by leading New Dealers–Ickes, Francis Biddle, Thurman Arnold, Archibald MacLeish, Aubrey Williams, Herbert Lehman, Elmer Davis and many others–rejecting Wallace and calling on liberals to vote for Truman because "the Progressive Party has lined up unashamedly with the forces of Soviet totalitarianism." Culver and Hyde do not quite defend the Wallace of 1948, but they let him down more easily than he deserves. In the end, he came in fourth, behind even the Dixiecrat candidate, Gov. Strom Thurmond of South Carolina.

When North Korea invaded South Korea in 1950, Wallace broke with the Progressives and backed the United Nations and the United States. He had meanwhile retired to his experimental farm in upstate New York. Working with plants and chickens, he was a serene and happy man. Thinking about politics, he was bitter and defensive, firing off letters to people who he thought had traduced him. He voted for Eisenhower in 1956 and gave Nixon some support in 1960.

In 1961 Kennedy invited him to his inauguration ceremony and luncheon. Wallace was much touched. "At no time in our history," he wrote Kennedy, "have so many tens of millions of people been so completely enthusiastic about an Inaugural Address as about yours." Wallace died in 1965 of Lou Gehrig's disease, a nearly forgotten man.

Culver and Hyde have done a sound job of restoring him to history. There are a few minor errors: It was the newspaperman Gardner Jackson, not the economist Gardiner Means, who had been involved in the Sacco-Vanzetti defense and was purged from the Department of Agriculture in 1935; it was Harry Dexter White, not Lauchlin Currie, who helped invent the World Bank and the International Monetary Fund; neither F.O. Matthiessen nor William Henry Chamberlin was a Harvard historian (one was a Harvard professor of literature; the other had no Harvard connection), and both their names are misspelled. But in the main "American Dreamer" is a substantial and workmanlike biography of a valuable, perplexing and indomitably naive public official.

Early Statistics at Iowa State University, Jay L. Lush, Chapter 5: The Wallace Lectures

An outburst of statistical activity in the Bureau of Agricultural Economics in Washington began about 1919 and was fueled for many years by the economic dislocations of agriculture which became apparent at the end of World War I. Naturally, much of this centered on costs of production and on techniques for predicting trends in prices and production. Multiple correlation and regression occupied the center of the stage in descriptive statistics during the few years before 1920 and far into that decade.

Henry A. Wallace was then an editor of Wallaces' Farmer in Des Moines. He was also highly interested in research, especially in the fields of plant and animal breeding and economics. His short paper, "What is in the Corn Judge's Mind?" will illustrate some of his interests, his enthusiasm for new ideas, and the proficiency he already had in multiple correlation.

Wallace's father, Henry C. Wallace, was Secretary of Agriculture from 1921 until his death in 1924. Henry A. visited Washington frequently during this time, both to see his father and as part of his editorial interest in "seeing what was cooking" in agricultural research and policy. He became enthusiastic about the statistical methods he saw being used so actively in the Bureau of Agricultural Economics and, to a lesser extent, in other bureaus. He was especially interested in the laborsaving potentialities in computing with punched-card machines. Those who began their statistical apprenticeship later than the early 1920s can scarcely imagine the many hours previously spent by high-powered research men in the drudgery of computing correlation coefficients one by one. Only the most tenacious and devoted could come through those ordeals with enough enthusiasm and time left to do the real work of finding the basic biological, economic, or physical mechanisms which were causing their data to behave as they did.

Wallace, as a loyal alumnus of Iowa State, was most eager that the faculty of his alma mater should know these newer statistical methods and use them wherever appropriate. Some of the faculty members challenged him to show them what was really new in this area. He accepted this challenge and spent his Saturdays in the spring of 1924 at Ames, explaining and illustrating to a class of some twenty faculty members and graduate students the things which seemed to him new and useful, especially those which promised to reduce the drudgery of computation. C.F. Sarle, who was then doing graduate work in statistics at Drake University, came with him on some of the trips. Several lessons near the end of the series dealt with using punched-card machinery for computing. For these lessons Wallace and Sarle borrowed some card-handling equipment from an insurance company in Des Moines, hauling the machines back and forth each Saturday as they were needed.

Wallace was determined that these efforts should grow into something permanent if that would fill a real need at the university. One step in this campaign was the publication of *Correlation and Machine Calculation* (1925). The illustrative data were from Sarle's M.S. thesis. Wallace wrote most of the first draft but Snedecor did the final work, helping especially with keeping it straightforward mathematically. He had helped thus during the whole series of lessons, although Wallace had full responsibility for planning and conducting the course. A revised edition appeared in June 1931. Both editions, but especially the first, were models of lucid writing and were widely influential. Many of the statements were simplified for brevity and some qualifications were omitted for clarity, especially in the first edition. This publication did much to popularize statistical methods and to raise hopes about what could be learned by using them. Many research workers who were using correlations but were not mathematicians themselves kept *Correlation and Machine Calculation* on their desks as an indispensable manual. Some even entrusted their computing to clerks, letting then use this publication as a desk guide.

Snedecor had a card punch and verifier in this possession when A.E. Brandt joined the staff in 1924. The two of them started helping colleagues analyze research data. They would take the punched cards to Des Moines on Saturdays and use a sorter and tabulator at one of the insurance companies. The success and the inconvenience of this led to establishing the Mathematics Statistical Service in 1927 with Snedecor and Brandt in charge. As part of this service the university installed IBM card-sorting and tabulating machines for the first time. The machines were first located at the Physics Building where direct current was available. In the second year they were moved to the third floor at Beardshear Hall, with a generator of direct current installed especially for them.

The Mathematics Statistical Service was rearranged in 1933 to be the Statistical Laboratory. This was responsible directly to the president, rather than going through the Department of Mathematics. The laboratory and the machines, now increased and replace with 80-column models, were established on the ground floor of the Old Office Building. There they remained until moved in 1939 to the Service Building, now Snedecor Hall.

What is in the corn judges mind? Journal of the American Society of Agronomy, 15, 300-304. SUGGESTED READING Childs, A. W., & Melton, G. B. (1983).Â Livestock judges: How much information can an expert use? Organizational Behavior and Human Performance, 21, 209-219. Seabrook, M. F. (1972). â€˜ What Is in the Corn Judgeâ€™s Mind? â€™, Journal of American Society for Agronomy, 1923). Banks found the same when they introduced models for credit decisions. â€˜In other fields, from predicting the performance of newly hired salespeople to the bankruptcy risks of companies to the life expectancies of terminally ill cancer patients, the experience has been essentially the same. In short, the corn crop is highly productive, but the corn system is aligned to feed cars and animals instead of feeding people. There are a number of ways to improve the delivery of food from the nationâ€™s corn system. First and foremost, shifting corn away from biofuels would generate more food for the world, lower demand for grain, lessen commodity price pressures, and reduce the burden on consumers around the world.Â The monolithic nature of corn production presents a systemic risk to Americaâ€™s agriculture, with impacts ranging from food prices to feed prices and energy prices.