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Categorizing the Adopters of Agricultural Practices

A method is suggested by which the adopters of agricultural practices may be classified into the five adopter categories of innovators, early adopters, early majority, late majority, and laggards. The criterion of classification may be either on the basis of (1) the time of adoption of a single new farm practice or (2) an adoption of farm practices scale.

Data taken from a 1955 study of 148 Iowa farm operators and from a 1957 study of 104 Ohio farmers show that adoption distributions over time are bell-shaped and approach normality.

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A MAJOR research area for rural sociologists in recent years has been the diffusion and adoption of agricultural practices by rural people. Findings as to the process by which new ideas are adopted, the characteristics of the early adopters, the sources of information about new practices, and the time pattern over which adoption takes place have been reported.

As a means of easy reference, various titles have been used for the categories of the adopters of agricultural practices. For example, a subcommittee of the North Central Regional Rural Sociology Committee has proposed the titles of "innovators," "community adoption leaders," "local adoption leaders," and "later adopters."[1] Other terms,

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[1]North Central Regional Rural Sociology Subcommittee on the Diffusion of New Ideas and Farm Practices, *How Farm People Accept New Ideas* (Iowa Agr. Ext. Serv. Spec. Rep. 15; Ames, 1955), pp. 9–10.

The normality of the adoption distribution for 2,4–D weed spray was determined by means of the Smirnov test.[9] The Smirnov goodness-of-fit test is a means by which the probability that an actual distribution may have been drawn from a normal distribution can be determined. The advantage of the Smirnov test over the chi-square goodness-of-fit test is that it is more powerful, that is, there is less likelihood of Type II error.[10]

The distribution of the 129 adopters of 2,4–D weed spray over time appeared to be essentially a bell-shaped, symmetrical distribution. The Smirnov test for goodness of fit indicated that the adoption rate of 2,4–D weed spray is normal. The maximum deviation from normality is 12.49 in 1949, which is less than the allowable deviation of 15.45 at the 5 per cent level of significance. There is not sufficient evidence that the adoption distribution deviates from normality.

Ryan and Gross[11] eliminated from their analysis of hybrid seed corn adopters the 64 farmers who had "started farming since the practice began its spread." Presumably these researchers discarded data from all farm operators who began farming either after the date at which the first respondent became aware of the practice (1924) or first adopted the practice (1927). In the present study, only the farmers who had begun farming after they were aware of the practice were eliminated from the analysis.[12] If they began farming after they became aware of the practice, their actual adoption date might have been postponed because they could not adopt the practice until they began farming. There were 17 of these beginning farmers who were eliminated from the 2,4–D spray adoption distribution. Elimination of these 17 farmers resulted in a distribution that was more nearly normal. The maximum deviation from normalcy is 10.68, which is less than the allowable deviation of 14.39 at the 5 per cent level of significance (Table 1).

Data regarding the adoption of antibiotic swine supplements were also secured in the Iowa study. The adoption distributions (1) for all 105 adopters and (2) for the 95 adopters remaining after the elimination of the 10 farmers who began farming after they were aware of the practice were both found to deviate significantly from normality (Table 1).

Data were taken from field studies (1) by Ryan[13] of the adoption of hybrid seed corn in Iowa, (2) by Dimit[14] of the adoption of the same

[9]The method by which this statistical test is computed is described by E. J. Massey, Jr., "The Kolmogorov-Smirnov Test for Goodness of Fit," *Journal of the American Statistical Association*, ILVI (March, 1951), 68–78.

[10]Type II error is accepting a hypothesis when it is false.

[11]Ryan and Gross, *op. cit.*, p. 17.

[12]It might be pointed out that this method resulted in a loss of 13.2 per cent of the data, while the method utilized by Ryan and Gross resulted in an elimination of 19.8 per cent.

[13]Bryce Ryan, "A Study in Technological Diffusion," *Rural Sociology*, XIII (1948), 273–285.

[14]*Op. cit.*

Table 1. Normality of adoption distributions for single practices

Practice	Percentage of adoption completed	Normality
	%	
2,4–D weed spray (all adopters)	87	Normal
2,4–D weed spray (beginning farmers excluded)	87	Normal
Antibiotics (all adopters)	89	Not normal*
Antibiotics (beginning farmers excluded)	89	Not normal†
Hybrid corn (Iowa)	100	Not normal*
Hybrid corn (Virginia)	100	Not normal*
2,4–D weed spray (Ohio)	76	Normal
Warfarin rat poison (Ohio)	78	Normal

*Deviation from normality is significant at the 1 per cent level of significance.
†Deviation from normality is significant at the 5 per cent level of significance.

practice in Virginia, and (3) by Rogers[15] of the adoption of 2,4–D weed spray and warfarin rat poison in Ohio.

Only the practices that were near complete adoption were tested for normality, as the adoption distributions for partially adopted practices would necessarily be nonnormal. All the adoption distributions were bell-shaped, and all approached normality, although half of those tested were found to deviate significantly from normality. Reasons for these inconsistent results are beyond the scope of the present article, although there seems to be some evidence that at least two factors are relevant: the intrinsic nature of the practice and the locale of the study.

Further research is needed to determine specifically why some adoption curves are normal and some are not.

ADOPTER CATEGORIZATION

Although the classification criterion of *time* of adoption has been utilized by most past researchers, the specific means by which time of adoption is measured has varied widely. Wilkening[16] and other research-

[15]These data were secured in field interviews with a state-wide sample of 104 commercial farmers in Ohio in 1957 as part of Ohio Agricultural Experiment Station Project Hatch 166, "The Communication Process and the Adoption of Farm and Home Practices in Ohio."

[16]Eugene A. Wilkening, "Informal Leaders and Innovators in Farm Practices," *Rural Sociology*, XVII (1952), 272–275. This criterion was also utilized by C. Paul Marsh and A. Lee Coleman, "Farmers' Practice-Adoption Rates in Relation to Adoption Rates of 'Leaders,'" *Rural Sociology*, XIX (1954), 180–181. It should be pointed out that "informal leaders," "adoption leaders," or "technological influen-

ers have used various sociometric techniques to label certain adopters as "informal leaders." The actual year of adoption of a new practice or practices would appear to be one of the best methods of using time of adoption for classification purposes. Wilkening[17] used the actual year of adoption in order to classify his farm operators as "community innovators" and "neighborhood innovators." Gross[18] classified the adopters of hybrid seed corn into four categories on the basis of year of adoption.

It was previously pointed out that theoretically adoption distributions might be expected to be normal and that in a number of empirical cases adoption distributions were either normal or closely approached normality. The normal distribution has two parameters, the mean (x) and the standard deviation (σ), which may be used to divide the distribution into five areas. These five areas under the normal curve are functionally labeled as innovators, early adopters, early majority, late majority, and laggards. These categories and the approximate percentage of the adopters that are included in each category are located on a normal frequency distribution in Figure 1. If this distribution were plotted on a cumulative basis, it would approach an "S" shape.

The area lying to the left of the mean year of adoption minus two standard deviations $(x - 2\sigma)$ would include the first 2.5 per cent of the farmers to adopt a new practice (innovators) as is shown in Figure 1. The next 13.5 per cent of the adopters would be included between $x - \sigma$ and $x - 2\sigma$ and are labeled "early adopters." At the mean year of adoption minus one standard deviation $(x - \sigma)$, a point of inflection[19] occurs. At this point, adoption ceases to increase at an increasing rate and begins to increase at a decreasing rate (and level off). Between this inflection point and the mean year of adoption, 34 per cent of the adopters are included in the "early majority" category.

Between the mean and the other inflection point (at $x + \sigma$) (where adoption begins to decrease at a decreasing rate) are included 34 per cent of the adopters labeled as "late majority." The last 16 per cent of the farmers to adopt a new practice (to the right of the inflection point at $x + \sigma$) are labeled as "laggards."[20] The two parameters of the normal distribution could be used to divide a continuous variable into any number of categories. The five categories used in the present case are an arbitrary number.

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tials" are really categories indicating degree of influence or leadership in the communication of technological practices. This dimension probably does not completely overlap with time of adoption. For instance, the innovator is the earliest to adopt but may not be regarded by his neighbors as a valid source of information or advice.

[17]Wilkening, *op. cit.*, pp. 272–273.

[18]Neal C. Gross, "The Diffusion of a Culture Trait in Two Iowa Townships" (unpublished Master's thesis, Iowa State College, 1942).

[19]R. L. Anderson and T. A. Bancroft, *"Statistical Theory in Research"* (New York: McGraw-Hill, 1952), p. 25.

[20]It must also be recognized that for practices that do not reach 100 per cent adoption, there will be a sixth category of "nonadopters."

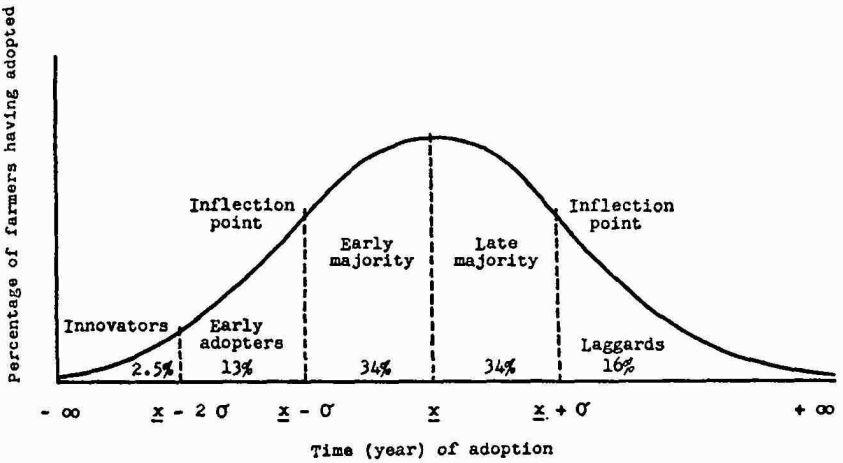

Figure 1. Adopter categorization on the basis of an adoption frequency distribution

STANDARD SCORES

The foregoing method of adopter categorization is essentially on the basis of "standard scores."[21] A standard score is computed by subtracting the mean $(\bar{x})$ from an observation (X_i) and dividing by the standard deviation (σ_x) of the distribution.[22] Where U_i represents a standard score, the formula may be expressed as:

$$U_i = \frac{X_i - \bar{x}}{\sigma_x}$$

A standard score is a "relative" type of score which, in effect, expresses the individual's position in relation to other members of a distribution. For example, an individual's year of adoption of a new practice when expressed in standard score form would indicate the individual's relative position in the distribution of adoption dates (of the other farmers in the study).

An advantage of standard scores is that the measuring unit is "pure," or free from the original unit of measure. For example, the time of adoption of a farm practice, such as using hybrid seed corn, may be mathematically compared with a widely different practice, such as using

[21]The use of standard scores as a means of classifying the adopters of a new practice has been utilized by Paul R. Mort and Truman M. Pierce, *A Time Scale for Measuring the Adaptability of School Systems* (New York: Metropolitan School Study Council, 1947). These authors divided school systems that adopted new practices into three categories (pioneer schools, early followers, and late followers) on the basis of the time of their adoption of new educational practices.

[22]For example, Farmer A adopted 2,4–D weed spray in 1948. The mean year of adoption is 1949 and the standard deviation of the adoption dates for 2,4–D weed spray is 2 years. The standard adoption score for Farmer A is 1948 minus 1949 divided by 2 which equals −0.5. This would place Farmer A in the early majority category.

commercial fertilizer. This advantage is important when constructing a composite adoption score composed of many practices. It is possible to add, subtract, or place weightings on each adoption item when it is expressed in standard form, even though the interval of time in which the adoption of each practice took place may vary.

The finding that all adoption distributions are not normal does not rule out the method of standard scores. Even in a skewed distribution, the use of standard scores may be utilized (with discretion) as the transformation of the raw data into standard score form tends to shape the distribution toward normality. In addition, little change is made in the number of cases appearing at different standard deviation units even when there is some departure from the normal distribution.[23]

ADOPTION OF FARM PRACTICES SCALES

Evidence has already been presented that the adoption of a single practice over time will approach a normal distribution. The distribution of scores on an adoption scale, composed of the adoption of a number of new practices, will also approach normality. The normality of these adoption scores facilitates the categorization of individuals into the five adopter categories of innovators, early adopters, early majority, late majority, and laggards.

A question might be raised as to whether an adoption scale (composed of the adoption or nonadoption of a number of practices) measures the general tendency to adopt new practices at an earlier point in time. The answer is "yes" when we consider that at any one point in time (the time at which the adoption scale is administered) the farm operator who has adopted, for example, twelve practices has generally tended to adopt practices at an earlier date than the individual who has adopted six practices. By determining only whether each farm practice in a scale is adopted versus nonadopted, only a rough (and indirect) estimate of the time of adoption of each practice is secured. More precise information could be obtained by inquiring as to the estimated date that each practice was adopted and by giving greater credit (a higher score) for adopting a practice at an earlier date. Most past adoption scales have not been of this more precise nature.[24] The researchers utilizing these adoption scales did not claim that they measured the general tendency to adopt new practices at an earlier

[23]James E. Wert *et al., Statistical Methods in Educational and Psychological Research* (New York: Appleton-Century-Crofts, 1954), p. 56.

[24]Lionberger, however, did secure information from his respondents not only as to whether or not they had adopted each of ten practices but also *when* they had adopted each practice. More credit was given to the individuals who had adopted practices at an earlier date. See Herbert F. Lionberger, *Information-Seeking Habits and Characteristics of Farm Operators* (Missouri Agr. Expt. Sta. Bull. 581; Columbia, 1955).

point in time, although the findings of the present article suggest they would have been justified in doing so.

A "simple" adoption scale was computed which credited an individual with one point for adoption and zero points for nonadoption of each practice.[25] A "standard adoption scale" was also computed which gave more credit to an individual who had adopted a practice at an earlier date. The coefficient of correlation between these two different types of adoption scales would be high if they both measured a similar tendency to adopt new practices at an earlier point of time. Correlation is +.90, which is more than that required to be significantly different from zero at the .001 level of probability.[26] Although only 81 per cent of the variation in one score is accounted for by variation in the other score, this finding provides evidence that even the simple type of adoption scale measures both the number of practices adopted and the *time* at which they were adopted. The advantage of the standard adoption scale is that fewer practices need to be included to measure the time-of-adoption dimension with equal precision.

The exact weighting that should be assigned to the year of adoption of each practice in a standard adoption scale may be computed by means of the method of standard scores.[27] This would guarantee equivalent weightings for the adoption of each practice independent of the span of years covered by its adoption period.

NORMALITY OF ADOPTION SCALE

It was mentioned previously that if the adoption distributions for single practices approach normality, then a distribution of adoption scores should also approach normality. In order to test this assumption, data were taken from the 1957 Ohio study described earlier to construct an adoption scale composed of 25 new farm practices.

The Smirnov goodness of fit test was utilized to test the hypothesis that the adoption scores are normally distributed. The maximum deviation from normality is 12.84 which is less than the 13.34 allowable deviation at the 5 per cent level of significance. There is not sufficient evidence to indicate that the distribution of the 104 adoption scores is not normal.[28]

[25]This adoption scale was composed of 25 recent farming practices. Data were secured from the 104 farm operators included in the 1957 Ohio field study mentioned earlier.

[26]A similar relationship of +.79 was found in the Iowa study mentioned earlier.

[27]For greater ease of statistical manipulation, one type of standard score, the "sten" score, might be used. See Charles H. Coates and Alvin L. Bertrand, "A Simplified Methodology for Developing Multi-Measure Indices as Research Tools," *Rural Sociology*, XX (1955), 132–141.

[28]The adoption scores in the Iowa study were also normally distributed. Maximum deviation from normality is 11.74, which is less than the 16.49 allowable deviation at the 5 per cent level of significance.

If a distribution of adoption scores is normal, then the individuals included in each of the five adopter categories may be determined on the basis of standard deviation units from the mean in a manner similar to that depicted in Figure 1 for a single practice. However, the characteristic measured is the time of adoption of farm practices rather than the time of adoption of a single practice.

The adoption scale for 25 practices in the Ohio study could range from zero to ten. The distribution of adoption scores was found to have a mean of 4.32 and a standard deviation of 0.59. The adopter category of innovators would include the individuals with adoption scores above 5.50 ($x + 2\sigma$). The early adopters would include the 14 farm operators (13.5 per cent) with adoption scores between 4.91 ($x + \sigma$) and 5.50. The adoption score limits for other adopter categories could be computed in a similar manner.[29]

CONCLUSIONS

The distributions of both (1) single practices over time and (2) adoption of farm practices scores were found to be bell-shaped and to approach normality.

Three principles of categorization were suggested near the beginning of this article. The use of time of adoption as the criterion for classifying adopters into categories fulfills each of these requirements. The categories are exhaustive, mutually exclusive, and are derived from one classificatory principle (time of adoption). The conclusion of this article is that the best criterion for classifying the adopters of agriculture practices is the *time* at which they adopt a practice or practices.

[29]Some evidence of the validity of this categorization was also secured. Each respondent was asked whether he considered himself (1) far ahead of the average, (2) ahead of the average, (3) average, (4) behind the average, or (5) far behind the average in adopting new farm practices. Correlation with adoption scores is +.35, which indicates that individuals perceive their relative adopter categories with some accuracy. In the 1955 Iowa study, correlation between self-ratings and adoption scores was +.69. The self-ratings of innovators and laggards were most accurate.