RISK ANALYSIS FOR AGRICULTURAL PRODUCTION FIRMS: CONCEPTS, INFORMATION REQUIREMENTS AND POLICY ISSUES

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CHANGES IN RATE MAKING FOR FEDERAL CROP INSURANCE

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This paper describes rate making practices of the Federal Crop Insurance Corporation (FCIC). A brief history of FCIC rate making practices is presented, along with some general principles of property-casualty insurance rate making. A model for future rate development is discussed.

Pure Premium Approach

The classical rate making method for property-casualty lines may be expressed as:

$$\text{indicated pure premium} = \frac{\text{incurred losses + loss adjustment expenses}}{\text{number of earned exposure units}}$$

The terminology quickly tells us that application of the formula is basically retrospective. It is retrospective because it considers incurred losses and earned exposure units, i.e., the observed results of a past period provide the data to be input. Incurred losses are losses attributable to experience during the base period. "Losses attributable" is not synonomous with "paid losses." Estimates of the incurred but not reported losses outstanding at the end of the base period are needed. Also, reported but unsettled losses at the end of the base period must be "reserved" (ultimate amount payable must be estimated) to fully depict experience. Finally, only the premium earned (accrual accounting) corresponding to the incurred losses is considered.

The indicated pure premium is converted to a rate by adjusting it for acquisition (agent's commission plus insuror's processing cost) expenses and a profit margin. These are expressed as fractions, resulting in the expression for rate:

$$\text{rate} = \frac{\text{indicated pure premium}}{1 - (\text{acquisition cost ratio plus profit margin ratio})}$$

This rate is an average for the exposure units included in the group.

The pure premium approach requires several conditions for it to be effective. Among them are:

1. The basic exposure unit must be well-defined and directly relate to the insured entity. Examples include private passenger automobiles (each vehicle-year is an exposure unit) and worker's compensation ($100 of payroll).

2. As generally used, the pure premium method relies upon data generated by the insuror's experience. Thus, any rate developed by the technique is technically valid only for a group of insureds substantially similar to that which generated the experience.

3. As a corollary to number 2, one must assume that the experience of the insuror encompasses all possible outcomes of the risk process subject to

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insurance in the same ratios as these outcomes exist in the population. If this is not the case, the calculated rate will deviate from the true value for the process.

4. Typically, the data used in the process are not simply the observed experience. Losses may be adjusted for trend. Various loss development factors are needed to estimate the total of the losses ultimately payable. Changes in policy terms and conditions must be assessed for impact upon rate level adequacy.

Most insurance companies simply do not have the breadth and depth of business to assure themselves that the rate developed from their experience is adequate. This is a reason for the existance of rating bureaus which collect the experience of numerous insurors and develop advisory rates for their members.

Loss Ratio Method

The loss ratio method is traditional for developing rate level changes in property and casualty lines. It is not a method for developing rates, which is a use of the pure premium approach as described above.1/ The loss ratio method seeks only to adjust an existing rate by comparing the realized loss ratio to an expected loss ratio for the line of business during a specified time period.

The loss ratio is expressed as:

$$\text{loss ratio} = \frac{\text{incurred losses + loss adjustment expenses during the experience period}}{\text{premium earned at current rates during the experience period}}$$

While the formula appears straight-forward, this is only an illusion. The previously noted problems of determining incurred losses also apply to the loss ratio method. The premiums which make up the denominator are not the income of the insuror. Rather, there are the estimated earned premium income had currently prevailing rates been charged during the entire experience period. This paper will not discuss the procedures of converting observed data to data which would have been observed had different conditions prevailed. It is sufficient to note that the task can be extremely tedious and time-consuming, especially if 2 or more years make up the experience period.

Once the loss ratio as defined above has been determined, the insuror develops a rate adjustment factor

$$\text{rate adjustment factor} = \frac{\text{loss ratio (actual)}}{\text{loss ratio (expected)}}$$

The expected loss ratio is 1.00 minus the expense ratio of the insuror (expense ratio is the cost of acquiring the business). In a sense, it is a target that the insuror seeks to meet or beat, subject to competitive forces. The rate adjustment factor developed by this process is a percentage change to be applied against existing rates. Note that the loss ratio is not total costs to total revenue. That ratio is the combined ratio, or the sum of the loss ratio and the expense ratio.

Judgment

Judgment is very commonly used in property and casualty rate making. This is especially true for lines with low volume and consequently, limited data. Aside from theoretical approaches employed by actuaries, judgment is the only viable approach for new lines of insurance. It is the oldest method of rate making.

The term judgment does not indicate that the process by which a rate is set is strictly subjective. Generally, a rate is set only after an examination of the physical property and/or financial documents and other data. An attempt may be made to forecast loss frequency and loss severity, often by comparing the proposed subject of insurance to similar lines. Market conditions and previous actions of competitors provide guidelines. In its strictest sense, the term judgment is used to describe rate making when there are no published rates which apply to a particular situation.

Pricing Considerations of Rate Making 2/

The rate charged by the insuror is a product price charged for insurance coverage on an identifiable unit of exposure. The unit of exposure can be any consistent and measurable base.

Pricing of the product typically is guided by two fundamental considerations: State regulatory constraints and the underwriting policies of the insurance company. While the specific pricing criteria listed by different authors may vary, most will differentiate regulatory criteria from self-imposed criteria. Important regulatory criteria include:

1. Adequacy--the rate charged must be sufficient to cover anticipated losses and loss adjustment expenses. This is a major consideration of the regulatory process since insuror insolvency is socially unacceptable. Adequacy generally is measured on the basis of an entire line of business in a specified rating territory (such as all private automobiles in a given State).

2. Not unfairly discriminatory--insurance company rates may discriminate among insureds provided the discrimination is fair, i.e., based on measurable criteria. Carried to the extreme, this criterion would imply that all insureds pay the rate which exactly measures their individual loss costs and expenses. This is not consistent with the concept of insurance, which is based on the idea of spreading the risk of unacceptable losses among a group of similarly situated risks. Thus, this criterion generally is applied to presumably homogeneous groups of risks.

3. Rates should not be excessive--Filing rates with the State insurance regulatory commission for approval before use has been a feature of the insurance industry for years. There is a fine line between adequacy and excessiveness. There appears to be a growing attitude that competition in the marketplace will adequately regulate rates. There possibly is more concern that aggressive marketing to achieve market penetration or to increase market share may drive rates below adequate levels.

4. Affordable--this is not strictly a regulatory constraint on insuror pricing since it typically is not specified by statute. It is regulatory in the sense that the insurance mechanism may be used to achieve certain social objectives. An example is the high risk or assigned pools commonly used in automobile insurance. There is a social objective that all drivers carry

insurance. The rates needed to insure the highest risk group of drivers would be so prohibitive that these individuals probably would refuse to purchase the coverage. This fails to meet the social objective. Thus, assigned risk pools are set up to provide coverage for these drivers. The large body of drivers in the acceptable risk categories subsidizes the high risk individuals by paying a slightly higher premium than they otherwise would.

Self-imposed Criteria of Acceptable Rate Making Processes

1. Encourage loss control and hazard reduction. A major concern of the insurance industry is that the price charged for the product encourages loss control. This attribute refers to the post-loss situation of minimizing the total damage suffered as a result of an insured event. An example is the general requirement of fire policies that the insured take steps to close openings in the damaged building to minimize further damage from the elements or vandalism. Hazard reduction refers to pre-loss incentives, such as lowered rates for installing sprinklers in a building.

2. Responsiveness. Changes in the perceived or actual nature of the hazard against which insurance is offered should be reflected rapidly in the rate charged. The change in the hazard may only be a perceived change because the previous notions upon which the rate was based resulted from incomplete knowledge of the stochastic nature of the event.

3. Stability. The counterpoint to responsiveness is stability. Most people prefer predictability in their lives, at least to the extent of their monthly expenditures. Sudden and sharp increases in the amount of the insurance premium may make current insureds vulnerable to a competitor offering currently lower rates. Sudden decreases affect cash flow projections and raise fears of adequacy. Frequent major changes lead one to ask if the company knows what it is doing. Moderate changes often will be accepted without undue concern.

4. Reasonably simple to develop and modify. Most insurors are confronted with the need to quote literally thousands of potential rates as they seek to segment the market with differentiated products, territorial differences, or multiple lines. Most will key to a few very basic rates, varying from these by fixed constants.

5. Profitability. Last, and certainly not the least, is the criterion that the activities of the insurance company must render positive returns to its owners; a fundamental condition of business activity.

The criteria outlined above represent one synthesis of the requirements of a valid rate making system. Different authors have different criteria or a different emphasis upon essential points. The ones given above do represent at least a minimum set of fundamental considerations.

Past FCIC Rate Making Activities

As of this writing, there is no documentation of the totality of rate making methods employed by the Federal Crop Insurance Corporation during its history. This paper will not pretend to present a definitive history. Rather, some fundamental rate making methods and recent approaches will be briefly described as an introduction to future activities.

Theoretical Approach

Early in its history (mid-1940's), the Corporation developed a basic theoretical model of rate making based on normal curve theory. The basic statement of this model is

$$P = \int_{0}^{c} (c - y_t) \; f(y_t) \, dy$$

where P is the pure premium, c is the insurance coverage offered, y_t is the annual yield, and f (y_t) is the distribution of y_t. The derivation of the model was provided by Botts and Boles (2, pp. 733-740) and will not be repeated here. The standard deviation of the distribution was set at .25 of its mean (coefficient of variation equals .25 for the standard normal distribution). Reasons for this choice are not documented. Old files do infer that this parameter was based upon data collected for an unknown number of farms in some counties of the Corn Belt. Theoretical rate making approaches became frozen at this point with some fairly gross rounding of the normal curve parameters so that computations on a mechanical calculator were facilitated.

The assumption that the standard deviation of yield was .25 of its mean yield was critical, as shown in Table 1.

Table 1. Theoretical Rates for Different Coefficients of Variation, 75 Percent Coverage Level, Normal Curve

Coefficient of Variation	Pure Rate	Loaded Rate
	(percent)	(percent)
.10	.03	1.14
.15	.40	1.56
.20	1.35	2.62
.25	2.78	4.20
.30	4.54	6.15
.35	6.51	8.35
.40	8.64	10.71

The effects of the steep incline in the pure rate are modified to some degree when flat loads (percentage points) are added for "catastrophe, unmeasured risk, and reserve margins." The loaded rates shown above have 1 percentage point added to the pure rate, and the resulting total increased by a 10 percent variable load.

There are some conceptual difficulties with the theoretical method as developed by FCIC. The method uses a time series of annual yields to estimate the fair and adequate rate. The intratemporal variation of yields is assumed equal to 25 percent of the mean yield. Some simple arithmetic rapidly shows that the calculated rate is influenced by the level of aggregation of the time series and its length. A long time series generally gives rise to a higher estimated rate, largely because of the influence of trend. The time series might be de-trended, but the potential that the older data is not representative of current production technology and risks still exists. Man did not create county boundaries to provide homogeneous risk units for crop insurance. Aggregation problems exist because of different sizes of counties and the range of production potential of the land mass within their borders.

Further, the indicated rate generally declines as one moves to higher levels of aggregation (the standard deviation of yield is declining). The method provides no measure of the degree of homogeniety of the land mass included in the average, nor does it provide any clues as to the appropriate distribution of the average rate over that land mass.

Another problem of this theoretical approach is familiar to all who have used time series--data are a scarce commodity. Typically, all available data are used to fit a model, leaving none to test it. The average yield of the time series determines the average coverage, but this coverage would not have existed in practice. Some other value based on unavailable (or no longer valid) information would have set the coverage offered. The variance of the time series influences the calculated rate, but there is no guarantee that all possible outcomes of the stochastic process have been observed during the sample period or that those which have occurred did so in their true proportions. Because of these and other considerations, the required rate should be estimated as a function of the pure premium defined above and some measure of variance, e.g.,

$$\sigma^2 = \int_0^c (c - y_t)^2 \; f(y_t)\, dy + \left(\frac{dc}{dy}\right)^2 \; \mathrm{Var}(Y)$$

The expression for rate then may be expressed as

$$P' = P + k\sigma$$

where P' is the rate charged, P is the pure premium defined earlier, and k is a parameter developed by applying the concepts of ruin theory.

Experience Rating

The theoretical rating process was intended to provide a starting point for the crop insurance offer. Once a program was established, rate making was based on the observed results of the insurance offer. The loss cost (indemnity divided by liability) was calculated for each year of experience. These loss costs were adjusted according to derived factors for differences in coverage levels over time.3/ This process is conceptually similar to the pure premium approach defined earlier.

Other adjustments were made for changes in the terms and conditions of the insurance offer during the experience period. These adjusted loss costs then were averaged. Subject to specified limitations on changes in the rate and degree of agreement with nearby counties, this average became the new pure premium for the county.

The calculated pure premium was adjusted for catastrophe, contract provisions, and a reserve allowance. The loading for catastrophe was a flat (percentage point) load while other loads tended to be percentages. The load for catastrophe in recent years was set to 0.0, 0.5, or 1.0 percentage point for a particular county. The amount depended upon whether the experience of that county was judged to indicate that a partial or full catastrophe already had occurred and thus already was reflected in the pure premium. Loads for contract provisions were designed to compensate for policy terms that would generate premiums or indemnities on a slightly different basis than that upon which rates were calculated. A common load in this regard was designed to compensate for expected discounts in premiums to individual policy holders for good insurance experience. The allowance for reserves was intended to be 10 percent, but in fact was 9.1 percent since the developed rate was multiplied by 1.10 rather than divided by 0.9.

Experience rating as used by FCIC has had some shortcomings. A major deficiency was the lack of a formally defined criterion for credibility. Too much emphasis was placed upon individual county data. This led to ad hoc adjustments in procedures whenever the developed rate was perceived to be invalid on the basis of individual judgment or when compared to neighboring counties.

Experience rating is useful and a well-established industry technique, but it properly should be applied in a consistent manner with a well-defined credibility standard. Smoothing of rates among classes or territories also is common. However, a set of rules should be imposed on the process. Ad hoc adjustments without formal rules can hamper meaningful statistical analysis.

The danger of relying solely on individual county experience for establishing county average premium rates is illustrated in the following results of a simulation run. The model is based upon the normal distribution. One thousand iterations representing the composite experience of 67 insureds for a ten year period are summarized in Table 2.

Table 2. - Simulation of the insurance experience of a group of 67 individuals, normal curve

Loss Ratio	Frequency	Cumulative Frequency
0.6 - 0.8	7.5	7.5
0.8 - 1.0	48.6	56.1
1.0 - 1.2	38.9	95.0
1.2 - 1.4	5.0	100.0

True rate	6.0 percent
Standard deviation	.2962
Calculated standard deviation	.3055
Calculated catastrophic frequency	.86 percent
Average loss ratio	.985

This particular model is constructed such that the premium rate is data input by the user. The model calculates the true standard deviation associated with that rate given that the distribution is standard normal. The group of 67 insureds is based upon an estimate of the number of observations required to be within $\pm$ .5 percentage point of the true value. If the rate maker had only a single 10 year experience period available, the inference that the original 6 percent rate was excessive by 25 percent or more is one possible outcome.4/ There is a 5 percent chance that the rate maker might conclude that this rate was insufficient by up to 40 percent. For this single run, there was a 45 percent chance that the 6 percent rate would prove inadequate.

The experience of a single individual is less indicative of the true rate that should be charged for the risk assumed by the insuror. The range in possible outcomes for any single individual included in this group is shown in Table 3.

Table 3. - Simulation of the insurance experience of a single individual, normal curve

Loss Ratio	Frequency	Cumulative Frequency
0.0	15.6	15.6
0.0 - 0.2	12.0	27.6
0.2 - 0.4	10.2	37.8
0.4 - 0.6	6.1	43.9
0.6 - 0.8	7.2	51.1
0.8 - 1.0	8.1	59.2
1.0 - 1.2	6.5	65.7
1.2 - 1.4	6.3	72.0
1.4 - 1.6	4.3	76.3
1.6 - 1.8	3.6	79.9
1.8 - 2.0	2.2	82.1
2.0 - 3.0	12.3	94.4
3.0 - 4.0	3.9	98.3
4.0 - 5.0	1.6	99.9
More than 5.0	.1	100.0

True rate	6.0 percent
Standard deviation	.2962
Calculated Standard deviation	.3048
Calculated catastrophic frequency	1.01 percent
Average loss ratio	1.00

Frequently, FCIC had far fewer than 67 insureds in a county for a full 10 year period. The probable range of outcomes of the county's aggregate loss ratio thus would be even more extreme than indicated in Table 2.

Table 3 demonstrates non-trivial probabilities that pure chance will deliver outcomes showing the insured to be either a very good risk or a very poor risk. It also shows that the premium adjustment table previously in the policies was inappropriate. That table provided a 35 percent discount for 10 continuous years of favorable experience with a cumulative loss ratio of 0.00-0.20. Table 3 indicates there is about 1 chance in 4 that fate alone will generate this outcome. Consulting actuaries who reviewed FCIC's rate making practices concluded that ". . . there is limited actuarial justification for maintaining a premium adjustment table that substantially complicates the rating system." (5, Task 8, p. 7).

Distribution of Rates

The discussion to this point has focused on estimating an average rate for a group. The demands of credibility theory frequently require that this average be estimated at a highly aggregated level. The aggregate rate frequently is segmented over smaller groups within the population in an attempt to more closely match rate charged to risk. This segmentation normally is done by set factors, specified mathematical formulas, or other somewhat mechanical means. FCIC rates are no exception in this regard. The county average rates (whether experience or theoretical) were spread over areas of the county. Spreading by farming practice or type (e.g., corn grain and corn silage) also was necessary. Similar techniques have been used in both cases.

A standard approach by FCIC was that of spreading the average rate in direct proportion to the area, practice, or type yield relative to average yield. This approach, designated as "same cost" or "flat cost", developed a constant premium. Mathematically, the rate for any subdivision is:

$$r_i = \frac{\bar{y} \times \bar{R}}{y_i}$$

where r_i = the area, practice, or type rate to be established

$\bar{y}$ = county average yield (or practice or type average yield)

$\bar{R}$ = county average premium rate

y_i = yield for the area, practice, or type associated with r_i.

Alternatively, we may write the expression as

$$r_i = \left(\frac{y_i}{\bar{y}} \right)^{-1} x \cdot \bar{R}$$

to emphasize that this model assumed a constant and inversely proportional response of 1 percent in rate per percent change in area yield relative to average yield.

Another reasonably common technique used by FCIC to distribute the average rate is the "increasing cost" model. This approach was predicated upon the belief that insureds should expect to pay more for higher coverage amounts. The approach "flattened" the rate response compared to the same cost model. Different weights to cost and rate produced this effect. Mathematically,

$$r_i = \frac{\frac{\bar{y} \times \bar{R}}{y_i} + (n - 1)\bar{R}}{n}$$

where n is the total weight and other variables are as previously defined. The larger the value of n, the more the distributed rates approach the average rate. The model develops higher premium costs as yields increase.

Occasionally, the distribution of rates for a county generated a "decreasing cost" response. It appears that this was not the result of any particular model. Instead, the variation in rate probably was introduced by manual adjustments from the same cost model. Decreasing cost structures have been uncommon.

Developments in Rate Making in FCIC

Introduction of actual production history (APH) programs effective for the 1985 crop year for selected crops forced a reevaluation of traditional approaches to distributing rates. The previous approach of defining geographic areas within counties and developing an average coverage for each area assumed that all land and operators within the area were homogeneous. Soil classifications became the primary classification characteristic in much of the country. Whenever this proved inadequate, individual operator or farm rating designations were superimposed upon the area structure. Some areas of the country did not use area maps for some crops, but used operator and/or farm listings instead.

The method of distributing rates under APH has an initial assumption that all operators with the same average yield within a rating area are homogeneous. The basic rating area remains the county, although this is based upon administrative considerations, not actuarial. Certain high risk areas (e.g., flood plains) are identified and surcharged from the basic rates.

County average rates for corn and grain sorghum were spread over yield ranges for 1985 by assuming an inverse rate response of -1.25 percent per percent change in yield relative to county average yield, i.e.,

$$r_i = \left(\frac{y_i}{\bar{y}} \right)^{-1.25} \times \bar{R}$$

where y_i is the centerpoint of a yield range, and other variables are as defined previously. The exponent of -1.25 represented a compromise. The consulting actuaries had recommended a model which was equivalent to an exponent of about -2.00 to -2.25. Most existing actuarial structures for corn and grain sorghum were of the same cost variety, i.e., the rates were equivalent to those generated by an exponent of -1.00. Recall that stability is one attribute of a desirable rating structure. Thus, the value of -1.25 served as a moderating influence to bridge into the new program while moving in the direction recommended by the actuarial firm.

Loads for catastrophe will be treated differently in the future, both in terms of estimation and in terms of distribution. Previously, the load was an arbitrarily determined percentage point factor which was additive to the pure premium. The consulting actuaries recommended that loss costs at the county level be capped at the 80th percentile for computing a basic loss cost. The excess of loss costs over the cap would be averaged across all exposure units at a higher level of aggregation. The average of the excess loss costs then would be added to the basic loss costs at the county level.

The distribution of the catastrophic load among individuals also must be changed. All procedures for distributing rate among individuals to date have spread the total rate. Obviously, this procedure charges a different catastrophic loading according to the relationship of yield to average yield. The constant cost model develops a proportional change in the catastrophic loading, e.g., 2 percentage points for yields which are 50 percent of average and .67 percentage point for yields that are 150 percent of average when the load is 1 point. The underlying concept of a catastrophic loading relates to extreme conditions over fairly large areas. Soil type, management ability, cultural practices and other factors may mitigate but not eliminate the adverse consequences of these conditions. A distributive procedure having greater intuitive appeal would distribute the unloaded rate, then add the load for catastrophe.

Past rate making focused on county data, by far the least credible information in the actuarial sense. Future efforts will use weighted averages of national, State, and county data to estimate the required pure premium. Isolating pure loss costs on a consistent basis will be difficult. Changes in policy terms and conditions, in coverage percentages and in the basis upon which coverage was determined, in rate making approach, and numerous other variables are confounded in the data. Adjustments must be made so that historical data are expressed on a basis comparable to current programs.

The credibility weighting schema must be defined. The first step in the rate making process is establishing a body of associated data large enough to establish an overall rate. That is the basic meaning of credibility - that the data are adequate to estimate the true required rate with a high degree of probability. The data need only be associated, not homogeneous.

Once the fully credible body of data and the overall rate are developed, rates for major classes and subclasses of the group must be determined. This typically is done by partial credibility factors or by rate relativities. Partial credibility factors relate available data for a sub-group to a standard for full credibility. A simple model for partial credibility which is applicable under certain circumstances is:

$$Z = \frac{\sqrt{n}}{\sqrt{N}}$$

where Z is the credibility factor, n is the information available about the sub-group, and N is the standard for full credibility. If we assume :

N = \$100 of incured losses (standard for full credibility)
n = \$ 30 incurred losses for a sub-group
r_1= .10 preliminary pure premium for the sub-group based on its experience
r_2= .06 estimated pure premium for the fully credible group

Then

$$Z = \frac{\sqrt{30}}{\sqrt{100}} = .5477$$

and: modified pure premium for sub-group $= r_1Z + r_2(1-Z)$

$$= .10\ (.5477) + .06\ (1-.5477)$$
$$= .0819$$

Rate relativities refer to patterns of relationships between rates for various groups. The relationship normally is expressed as a constant differential or a percentage factor, but it can be more complex. Establishing separate rates for oranges, grapefruit, etc., from a rate for citrus is an example of a situation in which one rate is set in direct relation to another.

The treatment of high risk areas must be determined. Some are relatively clear-cut. A flood plain is a hazard faced equally by all land included in it. Aside from the threat posed by this hazard, the crops may face hazards similar to those of the same crops in adjacent areas not subject to flooding. An additive load to the average rate thus may be appropriate. Any flood losses in the annual loss costs then must be eliminated before calculating the pure rate. Other risk areas are less definate. · Crops on sandy soils are prone to stress more frequently than average. Should this hazard be reflected with a loading for it, or should the ratemaker assume that the average realized yield already adequately reflects the hazard? Such questions must be answered.

More sophisticated approaches to the basic rate distribution model must be examined. The unsophisticated model for corn and grain sorghum discussed earlier reflected the time and resources available for conversion. The need for a constant in the equation to reflect the load for catastrophe and any special risk areas has been identified. Concern has been expressed that some producers may have low yields relative to an area average but also have small variances. Rate distribution models as formerly or currently used by FCIC do not recognize this condition. The implicit assumption of the rate distribution techniques is that the variance of yield is relatively constant, the basic condition described by Skees and Reed (8). Discounts under the premium adjustment table are alleged to have compensated in the past. Such discounts now are being phased out. The extent of the issue must be established to determine if the rate distributional formula should be modified to reflect such insureds. Alternatively, special underwriting considerations might be established.

FOOTNOTES

1/ The pure premium approach also may be used to develop rate level changes. It will generate the same result as the loss ratio method under certain conditions when used in this manner.

2/ This discussion draws from material presented in (4) and (5).

3/ The percent of average yield required to be insured was not specified until passage of the Federal Crop Insurance Act of 1980. Prior to that, only one level of coverage typically would be offered for a crop type or farming practice. Coverage levels varied from about 30 percent to a maximum of 70-75 percent in a limited number of counties. The mode prior to 1930 probably was around 55-60 percent. The coverage percentage in a county often was changed from one year to another while the rate would not be changed.

4/ The loss cost and the loss ratio are related by the premium rate. The loss ratio is the ratio of paid indemnities to earned premium. The loss cost is the ratio of paid indemnities to liability. Earned premium is equal to the premium rate multiplied by the liability. Thus,

$$\text{loss ratio} = \frac{\text{incurred losses}}{\text{earned premium}} \; ; \; \text{loss cost} = \frac{\text{incurred losses}}{\text{liability}} \; ;$$

earned premium = rate x liability;
and loss cost = rate x loss ratio.

The results of the simulations, although expressed in terms of the loss ratio, thus easily are converted into the loss cost, or a measure of the pure premium.

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