

Crop Insurance for Cotton: Premium Rates and Related Matters Executive Summary

Pages 67-68 of Senate Report 105-212, state the following:

Cotton producers participating in the Federal Crop Insurance Program pay significantly higher premiums and receive a lower indemnity per dollar of coverage when compared to other major commodities. In addition, cotton insurance premiums vary greatly among otherwise similar regions with little explanation. Within available funds, the Committee directs the agency to carry out a study to review current cotton crop insurance rates, rating practices, and compare current rates to other major commodities. The Committee urges the agency to use independent experts representing all geographic cotton-growing areas. (Report accompanying S. 2159 Agriculture, Rural Development, Food and Drug Administration, and Related Agencies Appropriation Bill, 1999)

This report is a progress report to comply with that directive. The cotton crop insurance program in the States east of Oklahoma and Texas (except Virginia) was reviewed. Virginia is not included because there was insufficient information. However, the results for other States in the Atlantic coast region can provide guidance with regard to this State. Review of the remaining States is underway. Premium rates for cotton will be adjusted for the crop year 2000 to reflect the results of this study. In many cases, premium rates will decrease. The exact amount of the decreases, both in terms of the overall levels and the effect within each State, is being determined in a separate analysis.

Highlights of the report are summarized below.

Three premium rating methods traditionally have been used by the insurance industry. Those are judgement, loss ratio, and pure premium (loss cost). A newer method, one that is not yet widely adopted, is mathematical or statistical modeling. RMA primarily uses the pure premium method because it is the most appropriate for the data, is objective, and is the simplest to implement operationally. RMA has used modeling in certain circumstances.

The report describes RMA's premium rate-making methods in detail to assure there are no misconceptions about the treatment of losses among States and crops. All calculations remain within a State and a crop. Crops and States are not cross-subsidized. Methods are intended to meet standard industry characteristics of a desirable premium rate, including stability, responsiveness, provision for contingencies, promote loss control, and fair discrimination among insured persons.

Premium rates estimated from insurance experience data are valid only insofar as those data are valid indicators of the probable future losses of the population. This report indicates that the

insurance experience for cotton in some of these States may not provide valid information for setting premium rates for most producers. However, the experience does appear valid for some farmers who presently insure in some of the States, and this information must be considered as premium rates are adjusted. In other cases, the experience seemingly is random, developed independently of weather conditions.

There is no one, simple, easy solution for this situation. Much analysis of specific conditions must be undertaken and consultations with interested parties will be needed to identify appropriate changes. In particular, revisions must assure that controls are in place to minimize the chances that losses again will spiral out of control and lead to higher premium rates and low participation.

Premium rates for cotton were compared to other major crops in these States. In general, there is no indication that premium rates for cotton systematically are higher than for other crops.

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Cotton producers participating in the Federal Crop Insurance Program pay significantly higher premiums and receive a lower indemnity per dollar of coverage when compared to other major commodities. In addition, cotton insurance premiums vary greatly among otherwise similar regions with little explanation. Within available funds, the Committee directs the agency to carry out a study to review current cotton crop insurance rates, rating practices, and compare current rates to other major commodities. The Committee urges the agency to use independent experts representing all geographic cotton-growing areas.

This report is submitted to respond to this directive. It is organized in the following manner:

- I. Insurance rate-making principles and methods
- II. Rate-making methods and practices of RMA
- III. Review of current cotton insurance premium rates in selected States
- IV. Comparison of premium rates for cotton to other major commodities
- V. Summary

I. Insurance rate-making principles and methods

Rate-making Principles

Rate-making techniques in the commercial insurance industry are intended to develop a price structure adequate to cover claims and the operating costs of the insurer and provide a reasonable profit while not being so high as to be noncompetitive. Federal crop insurance has similar objectives in its rate-making processes, except that the price structure need only be adequate to pay expected losses and build a reasonable reserve. Expenses are not included in crop insurance premium rates, but instead are paid from the Treasury as subsidy on behalf of the producer.

¹ Report accompanying S. 2159 Agriculture, Rural Development, Food and Drug Administration, and Related Agencies Appropriation Bill, 1999.

Any insurance rate-making system also has secondary objectives. Commonly, these include:

Stability. Premium rates that are highly volatile from year to year are disconcerting to policyholders. Most consumers prefer predictability to wildly fluctuating prices. Thus, rate-making techniques normally incorporate procedures to promote stability, especially for a product that is subject to infrequent occurrences of extremely severe events, as is the case for crop insurance.

Responsiveness. Rate-making techniques are responsive if changes in the loss exposure are incorporated into the premium rates without undue delay. In some respects, responsiveness and stability are competing objectives. However, both must be pursued.

Provide for contingencies. Premium rates are forecasts of future losses. Thus, they are imperfect. Circumstances change over time. New varieties of a crop may be developed. These new varieties may have risk characteristics that differ from older varieties. The data available for rate-making typically are not adequate to reflect all the circumstances that might result in a loss. For crop insurance, more years of data are preferred so that the extremes of adverse weather are included. However, as the number of years increases, the data become less representative of current production conditions and technology. Hence, rate-making procedures typically include some loading for the unknown and unknowable.

Loss control and loss reduction. Insured persons should have incentives to control the occurrence of and the amount of losses. Since premium rates are driven by expected losses, they can be made more affordable only if insured persons retain incentives to avoid losses when possible or, when a loss does occur, to minimize the amount of the loss. The first incentive is called loss control. In crop insurance, loss control is stimulated by such actions as requiring that a deductible be met before any loss becomes payable. The second incentive is called loss reduction. In crop insurance, loss reduction is the goal of policy provisions such as those that require all production of a crop be counted against the guarantee, even if unharvested.

Discriminate risk appropriately. Premium rates must recognize the risk that is presented by a particular class of insured persons. For example, younger persons are charged higher premiums for automobile insurance because such persons as a class present a greater risk of loss. Rates must discriminate among classes of insured persons in an objective manner. In crop insurance, premium rates discriminate among crop production practices, among producers at different average yields, and in other ways. However, rates cannot arbitrarily discriminate, or the effectiveness of the rating system will be lost.

Other objectives could be stipulated, but these five are adequate to provide a basis for describing the rationale of the premium rate-making processes employed by the RMA.

Insurance industry rate-making methods

Most insurance textbooks identify three generic methods for rate-making: judgement, loss ratio, and pure premium (loss cost).

Judgement. This is the oldest of the rate-making methods used in the insurance industry. As the term implies, the intuition of the rate-maker plays a major role in setting the rate. Its major use in contemporary insurance is for unusual or unique situations. In Federal crop insurance, the initial premium rates for a new crop may be influenced by judgement because reliable data for an extended historical period rarely exist.

Loss ratio. This method appears simple but often is misleading. Simply put, the losses paid to policyholders are summed and then divided by the sum of the premiums paid by those policyholders expressed on current rate level. A ratio greater than 1.00 indicates that more losses have been paid than premiums that would have been earned at current rate level, suggesting that an increase in the premium rate is needed. The converse also applies. The reason that a loss ratio can be misleading as to rate adequacy is discussed below. This method is most appropriate when the units exposed to loss are homogenous and do not change substantially over time. It is a method for adjusting an existing premium rate.

Pure premium method (loss cost). The term loss cost describes a ratio of the losses paid to policyholders divided by the insurance provided to those policyholders. It is called the pure premium method because the result is the premium rate that should have been charged to exactly pay those losses. For example, if \$100 of losses are paid and the insurance provided to policyholders is \$2,000, the loss cost is 5.0 percent. In other words, if a premium rate of 5.0 percent before allowances for expenses and profit had been charged, the insurer would have received enough premium income to pay the losses realized. The pure premium method calculates a new premium rate each time it is used whereas the loss ratio method adjusts a previously established premium rate.

These are the traditional insurance rate-making methods. A newer method is mathematical or statistical modeling. It is very appropriate when losses occur very infrequently and the magnitude of the loss is extremely unpredictable. Examples are potential damage due to hurricanes or earthquakes. Both happen rarely and the magnitude of the event is unpredictable. A premium rate typically is estimated by Monte Carlo simulation. Modeling is a form of the pure premium methodology in that it estimates a rate rather than changing an existing rate.

As an example of modeling, the expected frequency of hurricanes might be described by a specific probability distribution. The force of a hurricane, once one occurs, might be described

by a second probability distribution. The angle at which the hurricane approaches the coast and the point of landfall might be described by other probability distributions. The total damage resulting from a particular hurricane is described by the force of the hurricane, the angle at which it hits land, and the point of landfall.

Once all the probability distributions and damage models are estimated, Monte Carlo simulation proceeds as follows: first, a random number is drawn and applied to the hurricane frequency distribution. Most such random draws result in no hurricane. However, if a hurricane does result, a second random draw is taken to determine its force. Other random draws are made to establish the angle of approach and point of landfall. Once these values are established, the amount of damage is determined. After thousands of these random draws, the total damage is summed and divided by the total value of the property at risk during those thousands of random draws. The result is a pure premium rate, but one estimated through simulation rather than from insurance experience.

Modeling is very data intensive and requires skilled professionals from several disciplines when the exposures are complicated. It may not perform well for some coverages offered under the Federal crop insurance program because damage predictions may not be reliable. Since crop yields may be reduced by numerous factors, isolating the amount of damage due to a certain event (such as a prolonged dry spell that is less pervasive than a drought) may be difficult. Weather data may permit predictions of the probability that the dry spell will occur, but lack of reliable predictors of the resulting damage may preclude reliable estimates of required premium rates. In other cases, data may be insufficient. However, as will be discussed later, there are situations in which modeling of crop insurance coverage is possible.

Earlier, it was stated that the loss ratio method appears simple but may be misleading. The reasons for this statement are demonstrated with an example. Assume that a new crop is insured with an initial premium rate of 5.0 percent set by judgement (for example, by comparing its production characteristics and risk factors to a crop that has been insured in that area). Suppose experience in the first 3 years is:

Year	Liability	Premium	Losses	Loss cost	Loss ratio
1	\$2,000	\$100	\$150	0.075	1.500
2	2,500	125	50	0.020	0.400
3	3,000	150	375	0.125	2.500
Total	\$7,500	\$375	\$575	0.073	1.533

This experience is extremely limited, but suppose the management is concerned that the initial rate of 5.0 percent is not adequate, and decides to increase it to 6.5 percent in year 4, again relying on judgement. Assume that after the increase, the experience is (years 1 - 3 are repeated for convenience):

Year	Liability	Premium	Losses	Loss cost	Loss ratio
1	\$ 2,000	\$100.00	\$150.00	0.075	1.500
2	2,500	125.00	50.00	0.020	0.400
3	3,000	150.00	375.00	0.125	2.500
4	2,500	162.50	50.00	0.020	0.308
5	3,500	227.50	100.00	0.029	0.439
Total	\$13,500	\$765.00	\$725.00	0.054	0.948

At this point, management might ask: should this premium rate be changed once again, and if so, by how much? The average of the loss costs is 0.054 (5.4 percent); hence, the indicated pure premium rate using this method is 5.4 percent. Many persons would incorrectly assume that the rate calculated by the loss ratio method should be 0.948 times 6.5 percent, or 6.2 percent. Why is there a difference in the 2 estimates and why would the loss ratio method be applied incorrectly to arrive at a premium rate of 6.2 percent?

The loss ratio method is applied incorrectly because all the premiums must be stated at the current rate level. That is, the premiums for years 1, 2, and 3 must be recalculated using the premium rate of 6.5 percent that was in effect in years 4 and 5. That is what is meant by “current rate level.” The actual premium rate in the first 3 years was 5.0 percent. The data restated to current rate level are shown below.

Year	Liability	Premium	Losses	Loss cost	Loss ratio
1	\$ 2,000	\$130.00	\$150.00	0.075	1.154
2	2,500	162.50	50.00	0.020	0.308
3	3,000	195.00	375.00	0.125	1.923
4	2,500	162.50	50.00	0.020	0.308
5	3,500	227.50	100.00	0.029	0.439
Total	\$13,500	\$877.50	\$725.00	0.054	0.826

With premiums stated on the current rate level of 6.5 percent, the loss ratio is 0.826. When multiplied by the existing premium rate of 6.5 percent, the result is 5.4 percent – the same as the loss cost or pure premium method.

Standardizing premiums to current premium rate level is difficult, time-consuming, and may result in inaccuracies when exposure units are not homogeneous. Because the two methods result in the identical premium rate when applied to the same data, RMA uses the loss cost method to calculate premium rates.

There is another important point regarding the estimation of premium rates using either the loss cost or the loss ratio method. In this example, both are nearly identical if calculated as the sum of the losses for the 5 years divided by the sum of the liability for the 5 years (or the sum of the premiums for the loss ratio) or if calculated as the simple average of the annual loss costs or loss ratios. This occurs because the liability each year is similar in amount. However, suppose for whatever reason the liability in year 3 had been \$500 (perhaps a Payment in Kind program was offered as did occur in 1983) rather than \$3,000. The result of this change is shown below.

Year	Liability	Premium	Losses	Loss cost	Loss ratio
1	\$ 2,000	\$130.00	\$150.00	0.075	1.154
2	2,500	162.50	50.00	0.020	0.308
3	500	32.50	62.50	0.125	1.923
4	2,500	162.50	50.00	0.020	0.308
5	3,500	227.50	100.00	0.029	0.439
Total	\$11,000	\$715.00	\$412.50	0.054	0.826

The dollar weighted loss cost with this change is 3.8 percent (\$412.50 divided by \$11,000). The dollar weighted loss ratio declines similarly, to 0.577 (\$412.50 divided by \$715). However, the simple averages remain at 0.054 and 0.826 for the loss cost and loss ratio, respectively. The difference between these data and the previous data is critical. Should the premium rate be 3.8 or 5.4 percent? This question can be answered only by examining the reasons for the decline in business in year 3 and taking future expectations into account. Year 3 was a year of high losses. If it can be expected that business always will decline sharply in a year with high losses, the dollar weighted average of 3.8 percent would be appropriate. Since weather occurs randomly and there are no reasons to anticipate that crop insurance business levels will fluctuate in proportion to the severity of losses., RMA uses the average of the loss costs in its rate-making.

As an aside to this discussion, it should be clear that the historical loss ratio of the Federal crop insurance program provides no guidance as to adequacy of current premium rates. Historical premiums never have been corrected to current rate level in the reports of insurance experience. Hence, loss ratios calculated on the basis of the actual premiums for prior years are incorrect and misleading if one attempts to use these as an indicator of the adequacy of current premium rates.

II. Rate-making methods and practices of RMA

As stated above, the primary rate-making technique followed by RMA for crops that have been insured for several years is the loss cost or pure premium method. The steps to analyze the loss costs and the ways that the previously described characteristics of a desirable rate-making system are incorporated into the methods are described below. Two sample counties are used. One represents the experience for corn in Iowa and the other represents experience for cotton in Texas.

Charts 1A and B² depict insured acres as a percent of planted acres. The counties are similar in terms of the level of participation. Note that participation apparently has declined in the corn county during 1996 and 1997. This is not the case: the apparent decline consists of acres insured under the Crop Revenue Coverage and the Revenue Assurance plans of insurance. These data will be converted to yield based coverage and included in the analysis when premium rates are calculated for the 2000 crop year. However, losses in this county in those years were extremely low. Omission of the data from these 2 insurance plans would have no effect on the premium rate since RMA uses a simple average of loss costs, not the dollar weighted value. The loss costs for these 2 years will not change materially when the data from the other insurance plans are converted and included in the rate base.

Charts 2A and B contain several key pieces of information. First, consider the corn county. Yields in this county demonstrate a trend as exhibited by the straight, upwardly sloping line in the upper part of the chart.³ The county average yield as reported by the National Agricultural Statistics Service (NASS) for each year is charted around this trend line. In most years, the annual yield is fairly close to the trend line. However, in 1977, 1988, and 1993, the annual average yield is sharply lower than the trend line.

Additional data are depicted at the bottom of the chart. These points represent the loss cost for crop insurance for each year. The average of the loss costs is 5.4 percent. Note that the loss cost is less than 0.5 percent in most years. However, there are 3 years in which it is substantially greater. As one might expect, those 3 years are 1977, 1988, and 1993 – the same 3 years that the yield was below the trend.

The information in the chart for the cotton county is identical. In this case, however, no statistically significant trend line could be estimated.⁴ Thus, the fluctuations in the annual NASS yield are depicted relative to the average yield for 1976-1997. The NASS average yield is sharply lower than average in four years -- 1975, 1982, 1986, and 1992. Again, loss costs are much higher than average in those 4 years. In comparison to the corn county, the fluctuations of the loss cost are much more variable in the other years, indicating that this county perhaps has a

² All charts are contained in the Appendix.

³ The trend line is estimated for the years 1956-1997.

⁴ The trend coefficient for 1956-1997 was negative but not statistically significant.

higher variation in yield among farmers, among farming practices, or for other reasons. The simple average of the loss costs in the cotton county is 15.2 percent for the period.

Charts 3A and B also contain several key pieces of information. The leftmost vertical bars in each set depicts the average of the coverage levels purchased by producers each year. It is the weighted average of the number of acres insured at each of the coverage levels -- e.g., at 65 percent, 70 percent, or 75 percent.⁵ Coverage averaged about 70 percent in the corn county and slightly less than 65 percent in the cotton county. Since the average coverage level changes during these years, RMA makes the loss costs comparable over time by mathematically restating the average loss costs to the 65 percent coverage level. The 65 percent coverage level was chosen for this purpose because this is the level of coverage most commonly purchased since the late 1980s. Also, the experience at higher coverage levels can be recalculated at 65 percent very readily. The raw loss cost is shown in the charts as the second bar in each set while the third bar depicts the loss cost after the adjustment to the 65 percent coverage level. After this adjustment, the average loss cost for the corn county declines from 5.4 to 4.8 percent. In the cotton county, the adjusted loss cost is greater than the raw value in some years, about the same in others, and less in still others. This is because the average coverage level was under 65 percent in some years, over 65 percent in others, and at about 65 percent in a few years. The adjusted average for the cotton county is 15.0 percent compared to the original value of 15.2 percent.

Recall that stability in the premium rates is a major objective of an insurance rate-making system. The next step of RMA's rate-making methods is intended to achieve this objective. Refer once again to Chart 2A. This county had 3 major loss years. However, many counties in Iowa incurred major losses in 1983 whereas this county had no abnormal loss that year. This county's losses in 1988 and 1993 are not as severe as in other parts of the State. The cotton county has 4 major loss years, which again may or may not exceed long-run expectations. When confronted with such highly infrequent and variable events, insurance rate-makers frequently spread losses associated with those events over a larger geographic territory to gain a better estimate of their average effect. The method used by RMA is called "80th percentile capping." The method ranks the annual loss costs from smallest to largest. Then the year corresponding to the 80th percentile is determined. For example, if there are 20 years of data, the 80th percentile is the 16th largest loss cost. The loss cost for that year is substituted for the actual loss cost for the remaining 4 years. The excess of the losses and the associated liability over this cap is pooled at the State level. This process is illustrated below with the same example as used earlier.

⁵ Most crop insurance business is heavily concentrated in 1 or 2 of the coverage level choices. The levels differ by crop and county, but 65 percent is the most common in recent years.

The 80th percentile for this example is the loss cost for year 1, which is 7.5 percent. This value is substituted for the 5th largest loss cost, which is 12.5 percent. The average of the capped loss costs is 4.4 percent. The losses over the cap (\$150, which is (0.125 - 0.075) times \$3,000) is allocated to a pool with the excess of losses for all other counties in the State.

Year	Liability	Premium	Losses	Loss cost	Capped loss cost
1	\$ 2,000	\$130.00	\$150.00	0.075	0.075
2	2,500	162.50	50.00	0.020	0.020
3	3,000	195.00	375.00	0.125	0.075
4	2,500	162.50	50.00	0.020	0.020
5	3,500	227.50	100.00	0.029	0.029
Total	\$13,500	\$877.50	\$725.00	0.054	0.044

Charts 4A and B depict the effects of this capping of loss costs. The raw and adjusted loss costs from Charts 3A and B are repeated in these charts. After capping, the average loss cost is about 0.60 for corn and 8.5 for cotton. This reflects the differences between the two counties in terms of the “normal” levels of losses that occur in a typical year.

Next, RMA’s method compares the capped average loss cost in each county to its immediate neighbors (a concentric circle, i.e., all counties bordering the host county). Extreme changes in premium rates from county to county often simply reflect chance events. Thus, RMA smooths the county’s rate by averaging it with those neighbors. In counties that have significant acreage, the weighting is 60 percent to the host county and 40 percent to the neighbors. This corn county is very similar to its immediate neighbors. Its capped loss cost is 0.57 percent whereas its neighbors have a capped loss cost of 0.68 percent. The weighted average (0.57 times 0.60 plus 0.68 times 0.40) is 0.62 percent. The cotton county is less similar to its neighbors. Its capped loss cost is 8.5 percent whereas the neighbors have a capped average loss cost of 11.2 percent. The weighted average is 9.6 percent.

Next, to recognize the provision of the law requiring a reasonable reserve, and to incorporate the insurance rate-making objective of providing for contingency, the weighted average loss cost is divided by 0.88. This value was based on a set of assumptions about the probability distribution of losses at the national level. It is set at the national level because that results in the smallest amount of loading. If it were set at a lower level of aggregation (e.g., a county), the amount needed to achieve an expected loss ratio would be much larger.

The next step adds the average of the pooled loss costs at the State level (pooled losses divided by pooled liability) to the capped and smoothed loss costs. Losses due to prevented planting, replanting, and other coverages not directly related to yield loss that were removed from the loss

cost data before these calculations began are analyzed separately to estimate the appropriate charge for those coverages. These estimates are added to the previous results.

The result of these calculations is a “target” premium rate. This is the premium rate that would be charged to a producer at the county average yield if there were no limits on premium rate changes (such as the statutory limitation on rate increases).

The calculations described to this point have been made with data aggregated for all types and practices for a crop within a county. This is necessary because the crop insurance data by type and practice in any county can be very sketchy due to infrequent planting by producers. Insurance rate-making techniques seek data that are robust. This means that the data would not be changed substantially if only a few more observations were added. Thus, RMA aggregates the data for all types and practices (where these are distinguished) to make the data more robust. After the county target rate is established with the aggregated data, that target rate is multiplied by factors that reflect the relative riskiness of each type or production practice. These factors are based on insurance data drawn from larger areas than a county, on the relative importance of the production practice or type in an area, and from agronomic information published by State universities and other sources.⁶

The procedure to this point has developed an average premium rate by type and practice at the 65 percent coverage level. This rate is assumed to be appropriate for a producer whose Actual Production History (APH) average yield is similar to a longer-term average yield for the county. Premium rates for producers with APH yields that differ from average are determined with a mathematical formula. Extensive research demonstrates that, *on average*, the probability of a loss is greater for producers whose yields are below the average for the area and vice versa. Statistically, this condition indicates that the standard deviation of yield within an area does not change as rapidly as does the average yield. Thus, the coefficient of variation for a producer (the standard deviation of the producer’s average yield divided by that average yield) is larger for lower yielding producers (i.e., potential for loss is greater). The mathematical formula that changes the premium rate according to the producer’s APH yield recognizes this tendency. Since this tendency exists on average, this discrimination of premium rates among producers is fair.

Finally, premium rates are needed for the different coverage levels that are offered. Recall that the loss costs were standardized to the 65 percent coverage level. Rates at the other coverage levels are multiples of these rates. For example, rates at the 75 percent coverage level for many crops are 1.538 times the rates at the 65 percent coverage level and those at the 50 percent coverage level are 0.723 times the 65 percent rates. These factors recognize that losses are more

⁶ For example, a factor for the irrigated practice would be substantially different in one county versus another if the principal production practice in one county were non-irrigated but irrigated in a second. This is because the bulk of the insurance experience would be based on the non-irrigated practice in the first case and on the irrigated practice in the second. The average loss costs would be more reflective of the dominant practice.

frequent at higher coverage levels and the severity of loss also differs. RMA has several research projects underway to examine the stability of these adjustment factors across crops, areas, and average yields.

In summary, the rate-making methods used for crop insurance follow traditional insurance industry practices. The loss cost methodology is a standard methodology. Spreading large catastrophic events over larger areas is an accepted technique to gain a better estimate of the average effect of infrequent and severe losses. Premium rates are loaded for contingency. Premium rates charged to an individual producer are based on objective criteria.

These rate-making methods, based in standard actuarial techniques, do not commingle losses among crops or States. Each crop in each State is analyzed separately. There is pooling of losses among counties within a State to determine the average effect of very infrequent, very severe loss events. The county smoothing procedure (concentric circles) is the only point in the rate-making procedure at which losses in any county in any other State play a role in the premium rates. Under this procedure, a county is as likely to be adjusted up as it is to be adjusted downward.

The foregoing discussion focuses on the standard rate-making technique used by RMA. RMA also has used modeling in some cases, such as citrus trees in Florida. In this case, the probability functions were taken from a report issued by the National Hurricane Center of the National Oceanic and Atmospheric Administration. RMA would not have had the expertise to develop those probability functions by itself. Damage at various wind speeds was predicted from a model developed by a State university. This information was combined in a Monte Carlo simulation to estimate a pure premium rate for damage due to winds. A similar approach was taken for damage due to freeze. Since the direct effect of these perils could be estimated and there are few other perils that will break limbs or destroy the trees, the simulation was appropriate.

Modeling also has been used to develop premium rates for the Income Protection (IP) plan of insurance. This model typically utilizes 35 to 40 or more years of county average yields as reported by NASS. These data provide a long-term perspective with regard to fluctuations in yields in an area. However, the IP plan does not insure a county average yield. Thus, the variation of yields for individual producers is introduced with the yields certified under the APH rules. The data for those producers who have certified 6 or more actual yields at the enterprise unit level (all acreage farmed by the producer) are used in the model. Data for at least 50 producers are needed to be statistically robust. If data for fewer than 50 producers in a county are available, the information is aggregated across several counties. Monte Carlo simulation is used to estimate a pure premium rate.

III. Review of premium rates for cotton

Does the insurance experience accumulated under the APH plan provide a reliable indicator of future losses and therefore required premium rates for cotton? Many believe it does not – that the pool of insured persons has been so adversely selected that it is not representative of the larger population of cotton growers. RMA has attempted to evaluate this issue.

The initial analysis for this report focused on the southeastern and delta cotton growing areas -- i.e., cotton growing States east of Oklahoma and Texas. These areas were chosen for several reasons, among which are: cotton acreage has been increasing in recent years and insured acres at buy-up levels range from greater than 50 percent of planted acres in some States to near zero in others. It was believed that these States provided a wide range of participation and the reasons for those differences could be analyzed within the time and resources available. Evaluations for Texas and Oklahoma are nearing completion and will be reported separately. The remaining cotton-growing States will be completed as data become available.

RMA used professional assistance from Mississippi State University, Auburn University, Texas A&M University, and the National Cotton Council of America for this review. The major project work was performed by professional staff at Montana State University, the developers of the IP rating model. RMA determined that this model or a similar model would be useful for this review. Since the IP model had been developed, it was used rather than incur the costs and delays associated with developing a similar model. If price changes are not included in the simulation, the estimated premium rates from the IP model represent a pure premium rate for yield losses at an enterprise unit level of aggregation. The pure premium rates from this model do not include estimates of the losses due to unit division, prevented planting, quality, and other coverages. However, a high percentage of crop insurance premium rates is due to the risk of yield loss regardless of the form of the insurance. Thus, it is believed that the IP model provides an index against which to measure the current premium rates for the APH coverage plan. For example, if the premium rates from the 2 methodologies are fairly similar and there is high participation in the cotton insurance program, it is likely that the insurance experience used by RMA is reasonably reliable. If the differences are large and participation is low, the quality of the experience data is questionable.

The performance of the cotton crop insurance program in these States for 1980-1998 is shown in charts 5 through 14. Charts 5 through 14 depict the annual loss ratios and the yield ratio, which is the average yield for a year as reported by NASS divided by the trend (expected) average yield for the year. Recall that charts 2A and B demonstrate that large crop insurance losses are directly associated with deviations of annual yield from the trend or the average. That is, a low yield compared to the expected yield is accompanied by much higher than normal loss costs. If the crop insurance experience data for cotton in these States is reasonable for rate-making, it should exhibit similar characteristics.

Consider the chart for Alabama (chart 5A). In 1980, the loss ratio was approximately 200 percent. The yield ratio that same year was 82 percent, i.e., 18 percent lower than the expected trend yield for that year. As was demonstrated in charts 2A and 2B, the loss ratio should be greater than 100 percent when the yield ratio is below 100 percent. Further, the loss ratio should be larger as the annual yield decreases relative to the trend.

Because the extent to which the changes in the loss ratio are associated with changes in the yield ratio is difficult to discern in Chart 5A, the data are graphed differently in Chart 5B. In this chart, the yield ratios are ranked from lowest to highest along the horizontal axis. The corresponding loss ratios are shown in the chart. The expected shape of the graph would slope from left to right, with a sharp decline as the yield ratio becomes larger. The data for Alabama generally conform to this expected shape. There are a few “bumps” for years in which the losses do not change as expected. For example, one cannot tell from the chart whether the losses in 1995 were lower than expected or whether the losses in 1983 and 1997 were greater than expected. Both 1988 and 1998 appear to be unusual. More analysis of the data are needed to determine the causes of these departures from the expected shape, but the crop insurance experience data for Alabama generally follow the expected pattern. This is not the case in some of the other States. A summary of the patterns is given in the following chart.

Cotton in Selected States: Loss History and 1998 Participation at Buy-up Levels

State	Loss Pattern Summary	1998 Planted Acres Insured as Buy-up
Alabama	Conforms to expected pattern; a few years need further review; yield ratio is highly variable	78%
Arkansas	Does not conform to expected pattern; large downside yield ratios but small upside values	1%
Florida	Exhibits expected pattern but some years clearly do not; highly variable yield ratios	47%
Georgia	Exhibits expected pattern with 2 or 3 years outside the pattern; highly variable yield ratios	54%
Louisiana	Appears highly random with limited association of losses to yield ratio; yield ratios are not as variable as other States	5%
Mississippi	Exhibits expected pattern with a few unusual years; yield ratios more variable than in Louisiana but less so than other States	14%
Missouri	No insurance purchased until 1990; highly erratic losses since	<1%
North Carolina	Exhibits expected pattern with a few unusual years; yield ratios are highly variable	29%
South Carolina	Exhibits expected pattern with 2 or 3 unusual years; yield ratios are highly variable	10%
Tennessee	Appears highly random with limited association of losses to yield ratio; yield ratios have wide range	9%

Generally, these charts indicate that the insurance experience in Arkansas, Louisiana, Missouri, and Tennessee is meaningless -- the indemnities had no relationship to the weather conditions that produced the observed yields. Buy-up participation in these States was less than 10 percent of planted acres in 1998. In the remaining States, the loss ratio has changed in a more predictable manner as the yields change. The association is stronger in some States than in others. This indicates that the producers in those States who are buying insurance have losses that follow

changes in the weather. However, there is a very wide range in the percentage of planted acres insured at buy-up levels, ranging from 10 percent in South Carolina to 78 percent in Alabama. Consequently, even though the experience of insured persons appears to track changes in yields in those States, other factors must be involved.

Relating insurance experience to the yield ratio reveals no information about the segment of the population that chooses not to buy crop insurance. It only provides an indication as to whether or not the experience has any information for setting premium rates for at least a part of the population of cotton producers. During most of the years included in these charts, participation in the crop insurance program has been similar to the levels shown in the table. Since 1995, however, a higher percentage of acres have entered the crop insurance program at the catastrophic level of coverage. The experience of these producers is not sufficient to provide any indications of appropriate premium rates. However, the yields certified by those producers for the APH program can be used to provide an indicator. This was done with the IP rating method.

Premium rates at the enterprise unit level of aggregation were estimated for all participants in cotton crop insurance, including the catastrophic level of coverage, who met certain criteria.⁷ First, only the data for those producers who had reported 6 or more years of yields was used. This criterion eliminated a large number of producers in some counties. However, at least 6 years are needed to measure the variance of the yields of individuals relative to the variance of the county yield. Secondly, data were screened for statistical anomalies. For example, in one county in one State, the identical yield was reported for numerous producers for several years. After eliminating all producers with fewer than 6 yields and screening the remaining producers for statistical anomalies, fewer than 50 producers remained in the data base for some counties. In those cases, counties were aggregated until the threshold of 50 producers could be achieved.

Results of the analysis in these States is summarized in the table below. The APH premium rate is the average rate for the 65 percent coverage level that would have been paid by the insured producers in the 1997 crop year. If a producer chose catastrophic coverage in the 1997 crop year, this factor makes no difference: the rate that he or she would have paid at the 65 percent level was recovered from the actuarial tables. This premium rate is based on the average of all yields certified by each producer and is not an average computed unit by unit. Both the yield and the premium rate are based on solid planted cotton, not skip-row. It includes the surcharge for optional units for the reasons discussed below. The subsidized APH rate is 58.3 percent of the unsubsidized rate. The subsidized rate is the basis on which a producer would pay for cotton insurance.

⁷ There have been suggestions that the cotton growing experience of producers who choose not to buy insurance at any level should be considered in setting premium rates. RMA attempted to obtain information about such producers, but was unsuccessful. No long-term yield histories could be located through State universities or other sources. Since no information is available, estimates of the effect of such individuals on premium rates could not be made.

The IP premium rate is the average of the rates calculated with that model for all qualifying producers in a State. As indicated earlier, this premium rate does not include basic or optional units, prevented planting, quality, or any other coverage that might be included in the APH premium rate. The subsidized IP premium rate is 58.3 percent of the unsubsidized IP rate unless the IP rate is greater than the APH rate for any producer. In that case, the dollar subsidy for the IP coverage is limited to the amount that would be paid under the APH coverage plan. Because the IP premium rates exceeded the APH premium rates for some producers, the subsidized IP rate shown in the table averages approximately 66 percent of the unsubsidized rate.

Producers' decisions to purchase insurance and the level of protection purchased depend upon a number of factors. Among these are the individual producer's aversion to risk; the alternative risk management strategies available to the individual producer; wealth; the ability to self-insure; the cost of the insurance; and other factors. When considering crop insurance, producers do not consider the unsubsidized premium rate as an indicator of cost. Most producers probably have no idea of that premium rate. Instead, producers consider the subsidized premium rate as the true indicator of the cost of the insurance. Many producers, especially those who insure the greatest percentage of the acres, elect coverage on the basis of optional units. Thus, the subsidized APH rate for optional unit protection perhaps is the single most reliable indicator of the cost of insurance as perceived by producers. This is the reason that the subsidized premium rate including optional unit coverage is included in the table.

Premium Rate Summary: APH versus IP Selected States for Cotton

State	Unsubsidized APH rate	Unsubsidized IP rate	Subsidized APH rate	Subsidized IP rate	Column 3 minus column 2
Alabama	10.1	7.5	5.9	5.0	-1.6
Arkansas	12.9	4.2	7.6	2.9	+3.4
Florida	12.8	5.1	7.5	3.6	+2.4
Georgia	16.6	11.9	9.7	7.2	-2.2
Louisiana	15.6	5.0	9.1	3.3	+4.1
Mississippi	11.8	5.8	6.9	3.7	+1.1
Missouri	10.7	6.5	6.2	4.5	-0.3
N. Carolina	9.9	4.9	5.8	3.2	+0.9
S. Carolina	15.2	5.1	8.9	3.2	+3.8
Tennessee	11.4	9.0	6.6	6.1	-2.4

For these States, the IP revenue premium rates exceeded the IP yield premium rate by about 10 percent, or by approximately the same difference as between the basic and optional unit premium rates for the APH coverage.⁸ It is impossible to exactly compare the premium rates developed by the 2 methods because of the difference in the definition of units and for other reasons. But it is possible to use the IP premium rate as an *index* for comparing the APH premium rate among these States. If the difference between the rates is constant among States, some sort of systematic problem(s) might exist. If the difference is not constant, there probably are varying causes. The last column in the table represents the subsidized APH premium rate minus the unsubsidized IP premium rate.

For the purpose of this comparison, assume that the IP premium rate represents an estimate of the actuarially fair premium rate for cotton. If this were an actuarially fair rate, some percentage of

⁸ Although revenue coverages sometimes are represented as less costly than yield-only coverage, introducing price variability increases the premium rate when the price-yield correlation is low.

producers would buy at that cost. Since crop insurance is subsidized, more producers should buy at the subsidized premium rate. A high positive difference in the last column indicates that the *subsidized* APH rate exceeds the assumed actuarially fair premium rate. If this condition truly does exist, low participation in APH cotton crop insurance would be expected. A small positive or a negative difference indicates that the current *subsidized* APH rate is about equal to or less than the assumed actuarially fair value. In such cases, participation in the APH plan should be greater. The purpose of this comparison is not to demonstrate the magnitude of any rate difference, but instead to provide an index of producers' reactions to the current subsidized APH premium rates relative to their perceptions of the actuarially fair charge.

The differences, expressed as a percentage of the subsidized APH premium rate, are graphed against acres insured at buy-up levels in Chart 15. Missouri is omitted since it has small acreage and producers in that State did not participate in the insurance program until the 1990s. Thus, it may be atypical of the remaining States. The premium rate "gap" is the difference from the above table divided by the subsidized APH premium rate, e.g., the value for Alabama is -1.6 divided by 5.9, which equals -27 percent. It is expressed as a percentage because the difference could be small numerically but be a significant difference because the underlying premium rate also is small numerically.

With the exceptions of Tennessee and Florida, the percentage of acres insured does track with the premium rate gap. Participation declines rapidly as the gap becomes less negative (it should be negative in all cases if the IP premium rate truly were the actuarially fair charge). This suggests that many producers in some of these States do not regard the current APH premium rates as actuarially fair even when the subsidy is considered. Thus, even though the pattern of losses may correspond to changes in yields, the crop insurance experience may not provide sufficient information to estimate an appropriate premium rate for those persons.

These data indicate that the APH premium rates for cotton must be modified in some States. The reasons for the adverse insurance experience in these States must be identified so that the appropriate adjustments can be made. This effort now is underway and **will result in lower premium rates for some producers for the 2000 crop year**. Defining the exact amount of change by State and region within State is beyond the scope of this report. However, some possible adjustments include:

For those States with correlation of yield and loss ratio such as Alabama, Mississippi, and others, the experience might be mathematically adjusted to reflect the average yields of producers who do not insure presently. That is, the experience that has been accumulated would be used to set premium rates consistent with the average yields of those persons who contributed to the loss history and reduced for the remaining producers according to the formulas used by RMA to discriminate rates among producers.

Make appropriate adjustments to the insurance experience to eliminate events that occurred in the past but are not expected to reoccur in future years. For example, during

the late 1980s and early 1990s, cotton producers had a choice of 3 methods for calculating the average yield on which insurance was based. Producers were permitted to choose the largest value. This system no longer is offered. Losses that can be attributed to that system should be eliminated from the experience.

Use the premium rates estimated by the IP model after adjustment to recognize optional units, prevented planting, and other factors in those counties that had sufficient numbers of producers in the sample. Some preliminary analysis indicates these premium rates should be increased by 25 percent or more to accommodate optional units. However, the revised premium rates must adequately discriminate those persons who created the adverse experience.

In addition to revising premium rates, introduce statistical tools to monitor producers, agents, and loss adjusters. These tools would be designed to detect losses that differ in terms of frequency or severity from expected levels considering the yield expectation for the year. Once unusual situations are flagged, impose special monitoring to avoid degradation of the cotton crop insurance program once again.

Other approaches may be identified in consultation with insurance providers, producers' groups, and other interested parties.

Cost of cotton crop insurance relative to other crops

The Senate Report directs that the cost of cotton crop insurance be compared to other major crops. These comparisons are given in Table 1. Within each of these States, crop insurance experience for the 1998 crop year is compared for various crops. Corn, cotton, soybeans, and wheat were insured in all the States. Depending on the State, peanuts, grain sorghum, rice, or tobacco or some combination of these crops also were insured. Only minor acreage of several different crops were insured in a few of the States. Those crops are not included in the table.

Three levels of insurance coverage are included in the table: CAT, 50 percent of yield at 100 percent of price (50/100), and 65/100. The table includes this information:

number of policies (a measure of the number of producers who purchased coverage for that crop),

the net acres insured,

the insurance value per acre at the coverage level sold, which is the liability of the insurance in the event of a total loss of the crop,

the insurance value per dollar of farmer-paid premium as sold, which is the insurance value per acre divided by the farmer-paid premium,

the insurance value per acre recalculated at the 65 percent coverage level,

the insurance value per dollar of farmer-paid premium recalculated at the 65 percent coverage level (the 65 percent coverage level as sold does not change), and

Insert Table.pdf Here

the ratio of the insurance value per dollar of farmer paid premium relative to cotton.

The ratio of the insurance value per dollar of premium relative to cotton is a measure of the degree to which cotton costs more or less to insure than other crops. The ratio for cotton always will be 1.00 since it is the reference point. For the other crops, a value greater than 1.00 indicates that more insurance can be purchased per dollar of farmer-paid premium than cotton. A value less than 1.00 indicates that the other crops are more expensive. This measure provides a basis to compare relative costs among crops.

These three coverage levels were selected because these are the most likely to have significant acreage insured. The remaining coverage levels typically are low in participation.

Among the States and crops, only peanuts, rice, and tobacco consistently can be insured at a lower relative cost than cotton. The remaining crops sometimes have a lower relative cost and sometimes higher. Within crops, one coverage level might offer more value per dollar than another. This indicates that farmers in different counties are making different choices with regard to coverage purchased.

These data indicate that there is no consistent pattern that describes premium costs for cotton relative to other major crops grown in these States. However, cotton does not appear to consistently be charged higher premium rates than other crops grown in these States.

Summary

Premium rates for crop insurance are established with accepted and traditional insurance industry techniques. There are three standard techniques used by the insurance industry to set premium rates. RMA uses the pure premium (loss cost) methodology because it is the most appropriate for the data, is objective, and is the simplest to implement operationally.

Premium rates estimated from experience data are valid only insofar as those data are valid indicators of the probable future losses of the population. This report indicates that the insurance experience for cotton in some of these States may not provide valid information for setting premium rates for most producers. However, the experience does appear valid for some farmers who presently insure in some of the States, and this information must be considered as premium rates are adjusted. In other cases, the experience seemingly is random, developed independently of weather conditions.

There is no one, simple, easy solution for this situation. Much analysis of specific conditions must be undertaken and consultations with interested parties will be needed to identify appropriate changes. In particular, revisions must assure that controls are in place to minimize the chances that losses again will spiral out of control and lead to higher premium rates and low participation.

Analysis of the remaining cotton States is underway and will continue as the needed data become available.

Premium rates for cotton were compared to other major crops in these States. In general, there is no indication that premium rates for cotton systematically are higher than for other crops.

Insert Appendix A Charts.pdf Here