Underwriting Review of

FCIC COST OF PRODUCTION INSURANCE PLAN FOR COTTON

Work Order # RMA-03-0003

Blanket Purchase Agreement # 45-RMA1-3-0010

United States Department of Agriculture

Federal Crop Insurance Corporation

Risk Management Agency

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EXECUTIVE SUMMARY

Under section 522 (c) (9) of the Agricultural Risk Protection Act of 2000, the Risk Management Agency of the Federal Crop Insurance Corporation contracted with AgriLogic, Inc. to develop an insurance rating methodology for a cost of production insurance plan for cotton (COP). The proposed pilot will offer COP to cotton producers in 6 counties each in Alabama and California, 2 counties in Arizona, 3 counties each in Georgia, Mississippi and North Carolina, 4 counties in Louisiana, and 25 counties in Texas. Relative current crop patterns, the total acres eligible for the COP pilot is approximately 29% of total cotton acres in the country. The pilot will be for 4 years with an evaluation at the end of the third year. The COP task order is for 12 crops: Cotton, Corn, Soybeans, Wheat, Peaches, Cranberries, Apricots, Nectarines, Almonds, Onions, Rice and Sugarcane. A rating methodology for the latter 11 crops is under development and expected to be submitted after 2004. The reinsurance, administrative and operating, and producer premium subsidies legislated in the Federal Crop Insurance Act are included in COP.

COP is a modified form of enterprise unit revenue insurance. Whether losses are incurred and indemnity payments made is determined by revenue from cotton production, with the revenue guarantee defined by a percentage of an estimate of the cost of production. Land and other fixed costs are calculated as fixed percentages the produce of an average of past prices times approved yield. All other production costs are defined by self-reported expenditures. A set of ceilings, caps and other adjustments to the revenue guarantee and production cost estimates are applied in an effort to mitigate the potential problems of acreage and supply response, adverse selection, moral hazard and fraud that are inherent in any form of subsidized revenue insurance that relies on self-reported values of costs and/or revenues.

In this review, I identify several problems with the proposed COP plan of insurance and rating methodology, including but not entirely limited to:

(1) The multitude of ceilings, caps, and rate adjustments complicate enormously the task of constructing and administering COP. COP is extremely complex, difficult even for experts in the field to understand well, which is likely to lead to low farmer participation.

(2) The premium rates established in COP are inconsistent with the statistical properties of the economic variables of primary interest – the price received by cotton farmers, the quantity and quality of cotton produced and sold, and the cost of cotton production.

(3) The method developed for tailoring county-level rates to individual cotton producers makes no sense. Indeed, if a given farmer had an average yield, coefficient of variation and average profit margin each equal to the corresponding county-level value, then the premium rate for COP would be zero at all coverage levels for that farmer. The complexity and convoluted nature of the documentation for COP almost completely masks this undesirable property of the COP rating methodology. Moreover, this single characteristic is very likely to be the primary contributing factor driving the excessively low premium rates in COP relative to other comparable crop insurance programs.

(4) The NATMOD model generates deterministic pseudo-prices given U.S. crop production. These pseudo-prices do not correspond at all to the market for cotton for the following

reasons: (a) Market prices are random not (conditionally or unconditionally) deterministic. (b) Agricultural commodity prices are not determined only by realized U.S. crop production, rather they are the result of a complex interaction of a host of unpredictable, uncontrollable (i.e., random) economic factors. (c) The economic processes that generate prices, exchange rates, demand, supply and other important economic phenomena are not simple constant elasticity (log-linear) relationships such as those in the NATMOD simulator. We can be sure of one undeniable fact. NATMOD is incorrectly specified. The documentation for COP does not provide any information on the predictive, explanatory, or econometric properties of NATMOD. Perhaps the most well-understood and widely accepted conclusion in the economics and econometrics literatures is that simulation models like NATMOD perform extremely poorly in these dimensions.

- Statistically, actuarially, and economically the NATMOD simulation model is not a valid framework on which to base ratemaking for any form of crop insurance.

(5) The method used to calculate the price risk component generated by quality differences in cotton is invalid. A simple weighted average of the quality premiums and discounts for quality differences in bales of cotton sold at central markets does not produce an estimate of the spatial or temporal distribution of cotton prices nor of the risk and uncertainty due to unpredictable and uncontrollable future cotton prices. Moreover, if the method used to construct this average in COP had been unbiased, then the average of premiums and discounts over the large number of transactions occurring in a six-year period would be very close to zero, rather than the $887.8 million dollar loss estimate reported. Something is fishy in the way these calculations were done. Even if there is no error in how this numbers was obtained, the average of quality premiums and discounts does not produce a valid load factor to can be added to the MPCI-APH base rates.

- Statistically and actuarially this is not a valid way to determine price risk.

(6) The method for deriving the pseudo-distributions for cotton yields by combining the NASS and RMA data sets is illogical to the point of bizarre, *ad hoc* and untested. The rates produced by the simulation process do not represent actual experience or the characteristics of agricultural production or market price determination.

- Statistically and actuarially this is not a valid way to determine yield risk.

(7) The catastrophic load procedure makes little to no sense and has the potential to redistribute catastrophic losses from high-risk regions to low-risk regions.

(8) From the perspective of the very likely negative impacts on the economic well-being of crop producers, the consumers and other users of agricultural products, U.S. taxpayers, and the expected effects on the allocation of agricultural resources and the environment, developing and implementing a taxpayer-subsidized crop insurance program that is based on the total cost of production is a very poorly conceived policy initiative.

I recommend that this project be rejected. Subsidized cost of production insurance needs to be reconsidered. Failing that, the current approach ought to be abandoned completely.

UNDERWRITING REVIEW

To assist me in completing this review, I carefully read all of the documents included in the Cotton Cost-of-Production Pilot Crop-Revenue Insurance Plan, the collection of previous review reports submitted on this project, and the Milliman and Robertson report to the FCIC on catastrophic load procedures for multiple peril crop insurance (MPCI), I attended a one-day meeting in Kansas City in which AgriLogic presented the COP rating methodology and responded to questions about specific issues raised during that meeting, and I reworked algebraic derivations for calculating individual farmer rates from county-level base rates. The report is organized as follows. The next section contains a brief verbal description of the COP plan of insurance for cotton. This is followed by my responses to the specific questions listed in the work order and the supplemental review questions from RMA. Next are a set of brief discussions of the previous reviews of the COP plan of insurance for cotton. Last is a discussion of several additional issues with the COP plan of insurance, including analyses of the NATMOD simulation framework, methods used to calculate pseudo-yield distributions, methods used to calculate catastrophic loads, and methods used to calculate price variability in the COP plan of insurance. Important conclusions and other analyses are interjected at various places within the report and denoted with a leading bullet.

COP Summary and Overview

Under section 522 (c) (9) of the Agricultural Risk Protection Act of 2000, the Risk Management Agency of the Federal Crop Insurance Corporation contracted with AgriLogic, Inc. to develop an insurance rating methodology for a cost of production insurance plan for cotton (COP). The proposed pilot project is to offer COP to cotton producers in 6 counties each in Alabama and Cali-

fornia, 2 counties in Arizona, 4 counties in Louisiana, 3 counties each in Georgia, Mississippi and North Carolina, and 25 counties in Texas. In terms of current cropping patterns, the total acres eligible for the COP pilot is approximately 29% of total cotton acres in the country. The proposed pilot program is for 4 years with an evaluation at the end of the third year. The complete COP task order is for 12 crops: Cotton, Corn, Soybeans, Wheat, Peaches, Cranberries, Apricots, Nectarines, Almonds, Onions, Rice and Sugarcane. Development of a rating methodology for the latter 11 crops is ongoing and is anticipated to be proposed sometime after 2004. Reinsurance, an administrative and operating (A&O) subsidy of 24.5% of the net book of premiums, and producer premium subsidies as specified in section 508(e) of the Federal Crop Insurance Act are included in the submission.

The COP plan of insurance for cotton is a modified form of *enterprise unit revenue insurance*. COP is revenue insurance because the basis for an indemnity payment is the revenue received by an insured farmer. It is a modified form of revenue insurance because the basis for the guarantee is not a farmer-chosen percentage of expected or predicted revenue; rather it is a percentage of an estimate of the total cost of production. Land and other fixed costs are calculated as fixed percentages of the product of an Olympic moving average of past prices (specifically, the middle three of the most recent past five year's prices) times the approved yield. At the beginning of the insurance period, all other costs are obtained from self-reported estimates of actual expenditures. In the event of a claim, these other costs are obtained from self-reported values for the actual expenditures.

A series of ceilings, caps, and other adjustments to these cost measures are imposed in an effort to mitigate the potential problems of acreage and production responses, adverse selection, moral hazard and fraud that are inherent in any form of subsidized revenue insurance that relies on self-

reported values for cost and/or revenue. One such adjustment is that COP insurance will be offered at the enterprise level, not for optional units. Other adjustments are discussed later in this report.

The first step in the rating methodology is the construction of farm-level pseudo-distributions for cotton prices and yields in each county of the pilot program. First, NASS county-level data on crop yields for 1980 to 2001 were detrended and combined with the NATMOD simulation model to generate pseudo-prices given U.S. cotton production under current government programs and other market conditions. The maximum of these predicted pseudo-prices and the current marketing loan rate for cotton defines the expected price variable in the calculations for a county-level loss cost ratio (LCR) data set.

- The pseudo-prices do not correspond to the market for cotton. Market prices are random not conditionally or unconditionally deterministic. Agricultural commodity prices are not determined only by U.S. crop production. They are the result of a complex interaction of a host of unpredictable, uncontrollable – i.e., random – economic factors. The economic processes that generate prices, exchange rates, demand, supply and other important economic phenomena are not simple log-linear relationships like those in the NATMOD simulator.

Producer-level yield data was next obtained from RMA's APH database. These yield data were combined with the NASS Census of Agriculture and Agricultural Statistics Database data sets to increase the sample length. The 1997 NASS Census of Agriculture data contains information on yield quintiles, including the producer-level average yield and standard deviation within each quintile. In a given county, the RMA producer yield data set was used if it contained more observations than the NASS data, and conversely. When the RMA APH data was used, it was

sorted by average producer yield and arranged into quintiles comparable to the corresponding NASS statistics. Within each quintile segment, whether based on RMA or NASS data, AgriLogic assumed that the conditional distribution for producer yields is normally distributed, truncated from below at zero, with the same mean and standard deviation as in the NASS/RMA segment set for that quintile.

- The assumption that farm-level yields are normally distributed within a quintile is incoherent. It should be checked with the RMA APH data, using the farm-level observations in that data.

The five conditional yield distributions were then averaged by assigning each quintile density an equal weight of $\frac{1}{5}$. This produced pseudo-distributions for farm-level yields for each county that are similar in appearance to what one would obtain if nonparametric methods were used to calculate a distribution from a complete set of data. Unlike nonparametric density estimation, the COP method is *ad hoc* and is not based on any criterion or coherent statistical hypothesis, established concepts or procedures.

A pseudo-distribution of farm-level yields for each county and in each year was then constructed by first translating the 1997 median of the producer-level average yield for each quintile to the NASS county-level average yield data in each year from 1981-2001 on a fixed percentage basis. These individual producer-level pseudo-yields were then adjusted by randomly adjusting the distribution for each pseudo-producer in each year until the medians of average producer yields and average coefficients of variation for each of the generated pseudo-distributions of county-level yields match the corresponding statistics for the RMA APH data set.

- This procedure for cooking up a set of artificial yield distributions stretches the imagination beyond the limits of reason. It represents only one among a seemingly endless stream of ex-

tremely creative machinations employed by AgriLogic to create and invent numbers from thin air. Unfortunately, however, none of these procedures has a basis or foundation in accepted economic, statistic, actuarial, or financial principles or practices.

The pseudo-prices and pseudo-distributions for yields were then combined to calculate an LCR for each county. This LCR was calculated under the provisions of the COP plan of insurance assuming that each pseudo-producer in each pilot county participated in COP over the 21-year period 1981-2001. It was also assumed that current government policies and other market conditions were in place during this period for the purpose of generating each county's LCR. For each individual pseudo-producer, the following definitions were used to calculate the LCR:

$$Gross\ Revenue = Price \times Yield \times Harvested\ Acres + Government\ Payments;$$

$$Expected\ Revenue = \max\{RMACounty\ Price,\ Loan\ Rate\} \times Approved\ Yield;$$

$$Liability = Coverage\ Level \times Planted\ Acres \times \min\{Expected\ Revenue,\ Cost\ of\ Production\};$$

$$Indemnity = \max\{Liability - Gross\ Revenue,\ 0\}.$$

The calculated county-level LCR then is the ratio of the sum of all indemnity payments over all producers in the county in each year over the period 1981-2001 divided by the sum of liabilities for the same year,

$$LCR_t = \frac{\sum Indemnity_{i,t}}{\sum Liability_{i,t}}.$$

NASS Crop Reporting Districts were then used to calculate catastrophic losses at the 85% coverage level, using the efficiency ratio criterion of Milliman and Robertson. In each crop reporting

district, a catastrophic cap on the LCR was chosen subjectively by searching for "natural break points" in the data. Evidently, an individual catastrophic yield loss cap was calculated for each NASS crop reporting district.

- The catastrophic loading process makes little sense and has the potential to redistribute catastrophic losses from high-risk regions to low-risk regions.

The next step in the COP rating procedure was to smooth the county-level LCR's by combining each county's LCR data with that of neighboring counties. Beginning with 1981, the cumulative number of years of to and including the present year, $AY_t = \sum_{\tau=1981}^{t} I(Year = \tau)$, where $I(\cdot)$ is an indicator function that equals one if the argument is true and zero otherwise, and the cumulative number of acres planted, $AA_t = \sum_{\tau=1981}^{t} Acres\,Planted_\tau$, were calculated. The cumulated number of years since 1981 was divided by 30, which was subjectively judged to be the *critical* number of years of experience necessary to reveal the properties of a 30-year weather cycle.

- The 30-year weather cycle is not validated by any formal time series properties of the U.S. cotton yield data. It is well-accepted among agronomists, plant scientists, and meteorologists that rainfall, weather, and other aspects of the climate appear to be influenced by an 11-year sun spot cycle, a separate 33-year cycle due to the relative position of the moon's orbit, and a 75-year cycle that is presumed to be due to the periodic wobble of the earth on its polar axis. None of these are reflected in the COP analysis. The use of a critical experience value of 30 years is therefore almost certainly incorrect. At the very least, the time series properties of U.S. cotton yields should subjected to formal statistical analyses in the frequency domain to uncover a justifiable and reliable inference on this question.

The cumulated number of acres planted since 1981 was divided by 42,000,000, representing the subjective judgment of the critical number of acres planted necessary to achieve *full credibility*. This value equals 271 (a critical claim value at a 65% coverage level, obtained from a former FCIC employee in an undisclosed manner), divided by 0.08 (the proportion out of 100 years of simulated pseudo-producer yield distribution data that generated a claim at the 65% coverage level), and multiplied by 30 (the critical number of years of experience judged previously to be necessary for *full credibility*). The sum of the relative cumulative number of years of experience plus five times the relative cumulative acres planted was divided by six, and the square root of this weighted average was calculated to obtain a county *credibility*,

$$CountyCredibility_{i,t} = \sqrt{\frac{1}{6}\left(\frac{AY_{i,t}}{30}\right) + \frac{5}{6}\left(\frac{AA_{i,t}}{42\times 10^{6}}\right)} \equiv Z_{BC,i,t}\,.$$

The same procedures were applied at the NASS Crop Reporting District (CRD) and USDA Farm Resource Region (FRR) levels to smooth the county-level LCR data. Acres planted in the CRD were used to construct an acreage LCR according to the formula

$$LCR_{i,t}^{PA} = \sum_{j}\left(\frac{Planted\ Acres_{j,t}}{\sum_{k} Planted\ Acres_{k,t}}\right) LCR_{j,t}\ ,$$

where both sums are taken over all counties in the CRD containing the i^{th} county. The distances between the geographic centers of the counties within a given county's CRD were used to construct a distance LCR according to the formula

$$LCR_{i,t}^{D} = \sum_{h} \left[\frac{\frac{\sum_{k} Distance_{h,k,t}}{Distance_{h,j,t}}}{\sum_{l} \left(\frac{\sum_{k} Distance_{l,k,t}}{Distance_{l,k,t}} \right)} \right] LCR_{h,t},$$

again where all sums are taken over all counties in the CRD containing the i^{th} county. These two weighted averages of the individual county LCR's were then combined through a subjectively determined weighted average

$$LCR_{i,t}^{SC} = .6 \times LCR_{i,t}^{PA} + .4 \times LCR_{i,t}^{D},$$

where the superscript *SC* indicates the *surrounding county* LCR. The surrounding county LCR is then multiplied by the county credibility, $Z_{BC,i,t}$, and added to a corresponding credibility weighted CRD LCR and FRR LCR to get the county-level base rate according to the formula,

$$R_{i,t} = Z_{BC,i,t} \times LCR_{i,t}^{SC} + Z_{CRD,t} \times LCR_{CRD,t} + \left(1 - Z_{BC,i,t} - Z_{CRD,t}\right) \times LCR_{FRR,t}.$$

- These county-level credibility and unloaded base rate calculations, like many other methods employed in the COP analysis to mysteriously create weights and other desired numbers, are bizarre beyond belief. While extremely creative, they are totally *ad hoc* and based entirely on subjective judgments, lacking in any rational motivation, justification, or validation.

The next step is to add several *load factors* to the county-level base rates, including load factors for *prevented planting*, a *disaster reserve*, *quality*, *excess loads* redistributed back to the corresponding CRD and FRR levels, and cropping *practice*. Each of these load factors were calculated using similarly complicated, creative, and original thoughts and methods to those applied to obtain the base county rates. Each final practice specific county base rate, $PSCBR_{i,t}$, was then cal-

culated according to the formula

$$PSCBR_{i,t} = \left[\frac{\left(\frac{R_{i,t}}{DRF_{i,t}} \right) + FL_{i,t} + PP_{i,t}}{Q_{US,t}} \right] \times PF_{i,t},$$

where $DRF_{i,t}$ is the disaster reserve factor, $FL_{i,t}$ is the final excess factor, $PP_{i,t}$ is the regional prevented planting load factor region, $Q_{US,t}$ is the national quality load factor, and $PF_{i,t}$ is the practice factor, each specific to the i^{th} county.

- This ratemaking methodology is filled with *ad hoc* rating and loading procedures. The central feature of these procedures is that they are based almost entirely on hunches and subjective guesses by the developers at AgriLogic. The resulting premium rates have no mechanism for self-correction if any or all of AgriLogic's hunches or judgments prove incorrect. Other forms of crop insurance include provisions that adjust rates in response to loss experiences over time. I could not possibly justify or support a recommendation that the COP plan of insurance be reinsured by any private company.

- The loading procedures tacitly imply mutually exclusive stochastic processes governing quality risk and other contingencies. This assumption is clearly false. It is well-accepted in the agricultural economics literature that the premiums and/or discounts paid for the quality attributes of agricultural commodities are jointly determined with supply and demand conditions and the overall market price. When there is a relatively large quantity of high protein wheat available on the market, the protein premium tends to be low. If the total supply of all varieties and qualities of wheat is high, market prices tend to be low. But if this market con-

dition is associated with an above average crop of soft white wheat and below average production of hard red wheat varieties, the premium for higher protein in wheat tends to be very high.

The next stage in the COP rating methodology is customizing the final county-level practice specific base rates to individual producers. AgriLogic's approach to this begins by making three separate tacit assumptions about the relationship between rates and rating variables:

Assumption 1. The percentage deviation of the producer level rate from the county base rate equals the percentage deviation of producer level average yield from county level average yield,

$$AF_{AY,Producer\ A} = -\left(\frac{AY_{Producer\ A} - AY_{County\ A}}{AY_{County\ A}}\right) = \frac{BR_{AY,Producer\ A} - PSCBR_{County\ A}}{PSCBR_{County\ A}},$$

where $AF_{AY,Producer\ A}$ is the average yield adjustment factor, $BR_{AY,Producer\ A}$ is the producer level rate based on average yield, $PSCBR_{County\ A}$ is the practice specific county base rate for the county of producer *A*, $AY_{Producer\ A}$ is the 10-year average yield for producer *A*, and $AY_{County\ A}$ is the 10-year average yield for the county of producer *A*. Note that the negative sign on this adjustment factor reflects the assumption that a negative deviation from the county average should result in a higher base rate.

Assumption 2. The percentage deviation of the producer level rate from the county base rate equals the percentage deviation of the producer level average profit margin from the county level average profit margin,

$$AF_{PM,Producer\ A} = -\left(\frac{APM_{Producer\ A} - APM_{County\ A}}{APM_{County\ A}}\right) = \frac{BR_{PM,Producer\ A} - PSCBR_{County\ A}}{PSCBR_{County\ A}},$$

where $AF_{PM,Producer\ A}$ is the profit margin adjustment factor, $BR_{PM,Producer\ A}$ is the producer level rate based on profit margin, $APM_{Producer\ A}$ is the 10-year average profit margin for producer *A*, and $APM_{County\ A}$ is the 10-year average profit margin for the county of producer *A*. As in the case of average yield, the negative sign indicates that a higher profit margin is associated with a lower base rate for the individual farmer. AgriLogic uses a somewhat more complicated comparison of producer- and county-level profit margins, but the formula above represents the case when the situation where the average profit margin for the county is positive. The method employed by AgriLogic in the case of a negative county-level average profit margin make absolutely no sense to me whatever.

Assumption 3. The percentage deviation of the producer level rate from the county base rate equals the percentage deviation of the producer level coefficient of variation from the county level coefficient of variation,

$$AF_{CV,Producer\ A} = \frac{CV_{Producer\ A} - CV_{County\ A}}{CV_{County\ A}} = \frac{BR_{CV,Producer\ A} - PSCBR_{County\ A}}{PSCBR_{County\ A}},$$

where $AF_{CV,Producer\ A}$ is the coefficient of variation adjustment factor, $BR_{CV,Producer\ A}$ is the producer level rate based on the coefficient of variation, $CV_{Producer\ A}$ is producer *A*'s coefficient of variation in yields, and $CV_{County\ A}$ is the coefficient of variation in county-level crop yields or the county of producer *A*. Note that, unlike the yield and profit margin adjustments, a higher coefficient of variation is presumed to imply a higher base rate; hence the positive sign on this adjustment factor. Also note that, because the county yield is the average of producer yields, and since averaging over producers generally has the effect of reducing the coefficient of variation, the as-

sumption that a producer whose coefficient of variation matches the county coefficient of variation should be charge the county-level base rate is highly questionable. The result of this is that we are likely to significantly bias producer level rates upwards for "good" producers.

AgriLogic implicitly calculated the combined effect of the three assumptions described above by constructing a total adjustment factor that is a weighted average of the three individual adjustment factors. The weights in this average were created by estimating the simple correlations between the producer specific values of each rating variable and the producer specific loss cost ratios over a 26-year period (see page 56 of the COP white paper). The weights were then obtained by dividing the absolute value of each simple correlation by the sum of the absolute values of the three simple correlations,

Rating Variable	Absolute Correlation	Weight
Yield	64%	$29\% = \left(\frac{64}{64+73+82}\right)\times 100\%$
Coefficient of Variation	73%	$33\% = \left(\frac{73}{64+73+82}\right)\times 100\%$
Profit Margin	82%	$37\% = \left(\frac{82}{64+73+82}\right)\times 100\%$

The total producer level adjustment factor was then set equal to the weighted average of the three individual adjustment factors,

$$AF_{Total,Producer\ A} = W_{AY} \times AF_{AY,Producer\ A} + W_{PM} \times AF_{PM,Producer\ A} + W_{CV} \times AF_{CV,Producer\ A}.$$

The *implied producer specific base rate,* $IPs_{\text{Producer } A}$, is then based on the assumption that the producer level rate can be calculated by adjusting the county-level base rate using the total ad-

justment factor,

$$IPs_{\text{Producer } A} = PSCBR_{County\ A} \times \left(1 + AF_{Total,\text{Producer } A}\right).$$

- The foregoing discussion clarifies the COP documentation and fills in several missing details from AgriLogic's white paper. The version of the producer specific base rate is not obvious from even a careful reading of the white paper. However, examination of Figure 8 reveals that the implied producer specific rate is precisely equal to the sum of the producer level base rates for each of the three rating variables,

$$IPs_{Producer\ A} = BR_{AY,Producer\ A} + BR_{PM,Producer} + BR_{CV,\text{Producer } A}$$

$$= \$.0209 + \$.0278 + \$.0787 = \$.1274.$$

If we algebraically sum the three rating-variable-specific base rates in the white paper,

$$BR_{AY,Producer\ A} = PSCBR_{County\ A} \times \left(1 + AF_{AY,Producer\ A}\right) \times W_{AY},$$

$$BR_{PM,Producer\ A} = PSCBR_{County\ A} \times \left(1 + AF_{PM,Producer\ A}\right) \times W_{PM},$$

$$BR_{CV,Producer\ A} = PSCBR_{County\ A} \times \left(1 + AF_{CV,Producer\ A}\right) \times W_{CV},$$

we obtain

$$BR_{AY,Producer\ A} + BR_{PM,Producer\ A} + BR_{CV,Producer\ A} = PSCBR_{County\ A} \times$$

$$\left(1 + W_{AY} \times AF_{AY,Producer\ A} + W_{PM} \times AF_{PM,Producer\ A} + W_{CV} \times AF_{CV,Producer\ A}\right)$$

$$= PSCBR_{County\ A} \times \left(1 + AF_{Total,Producer\ A}\right).$$

- The three assumptions taken individually are almost surely incorrect for any given producer. Although the method for obtaining the weights for these adjustments has the advantage of simplicity (although the white paper has obscured this aspect comprehensively), it is *ad hoc* and arbitrary, and is not based on any established statistical or actuarial methodology.

AgriLogic next took several additional steps to derive the *completely individualized producer rate*, $PsR_{Producer\ A}$. These steps are primarily concerned with adjusting the implied producer specific rate for credibility. A *credibility percent factor* was derived from the producer's acreage and years of experience,

$$Cr_{Producer\ A} = \sqrt{\tfrac{1}{6} A_{Producer\ A} + \tfrac{5}{6} Y_{Producer\ A}}\ ,$$

where $A_{Producer\ A} = \dfrac{PA_{1992} + \cdots + PA_{2001}}{4,200}$ is the acreage credibility, PA_t being defined by the acres planted to cotton in year t = 1992, …, 2001 and 4,200 being defined by the product of 420 acres (the U.S. average number of planted acres for cotton producers) times 10 years (the maximum possible of years of APH experience), and $Y_{Producer\ A} = \big(I(PA_{1992} > 0) + \cdots + I(PA_{1992} > 0)\big)/10$ is the years experience credibility, with $I(\cdot)$ the indicator function defined above and 10 is again the maximum number possible of years of APH experience.

While $0 \le Y_{Producer\ A} \le 1$ necessarily, it is entirely possible that $A_{Producer\ A} > 1$. Moreover, since zero planted acres in any given year implies a zero in that year in the formulas for both credibility factors, the two measures are necessarily correlated and it makes little sense to simply average them as if they are not. Moreover, since the acreage credibility factor can exceed unity, and perhaps do so more than the years credibility factor is less than unity, it is not clear that the above square root of the weighted average produces any king of meaningful percentage credibil-

ity weighting.

Given the "percent" credibility factor, $Cr_{Producer\ A}$, a credibility-weighted adjustment from the county base rate is defined by

$$Aj_{Producer\ A} = Cr_{Producer\ A} \times IAj_{Producer\ A},$$

where $IAj_{Producer\ A} = \dfrac{PSCBR_{County\ A} - IPs_{Producer\ A}}{PSCBR_{County\ A}}$, the negative value of the percent deviation of the implied producer specific base rate from the county base rate. The *completely individualized producer rate,* $PsR_{Producer\ A}$, is then calculated as the product of a *final adjustment factor* and the county base rate,

$$PsR_{Producer\ A} = \overbrace{\min\left\{IAj_{Producer\ A}, \left(Aj_{Producer\ A} \times F\right)\right\}}^{final\ adjustment\ \ factor} \times PSCBR_{Producer\ A},$$

where $F = \begin{cases} 2, \ if \ \ 1 \le Z_{PM\ Producer\ A} < 2 \\ 3, \ if \ \ Z_{PM\ Producer\ A} \ge 2 \end{cases}$ and is otherwise undefined, with Z_{PM} the individual producer's excess average profit margin over the county's average profit margin, measured in standard deviation units.

To clearly elucidate the final individual rate calculation, rewrite the final adjustment factor as

$$\min\left\{IAj_{Producer\ A}, \left(Aj_{Producer\ A} \times F\right)\right\} = \min\left\{IAj_{Producer\ A}, \left(Cr_{Producer\ A} \times IAj_{Producer\ A} \times F\right)\right\}$$

$$= \min\left\{1, Cr_{Producer\ A} \times F\right\} \times IAj_{Producer\ A},$$

since all of the variables inside the min{·} term are positive-valued. Making the appropriate sub-

stitution and solving, we learn that

$$PsR_{Producer\ A} = \min\left\{1, Cr_{Producer\ A} \times F\right\} \times \left(PSCBR_{County\ A} - IPs_{Producer\ A}\right).$$

A simple illustration demonstrates that this formula producers nonsense for producer specific rates. Consider the case where a particular producer's values of the rating adjustment variables each exactly equals the corresponding county value. Then it is clear from the earlier discussion that

$$0 = AF_{AY,Producer\ A} = AF_{PM,Producer\ A} = AF_{CV,Producer\ A} = AF_{Total,Producer\ A},$$

which in turn implies that $IPs_{Producer\ A} = PSCBR_{County\ A}$, so that $PsR_{Producer\ A} = 0$! This is clearly absurd.

Summary of Major Findings

(1) The COP plan of insurance is extremely complex and difficult for anyone to grasp regardless of their level of training, background or experience. These attributes are likely to lead to low farmer participation.

(2) The premium rates are inconsistent with the statistical properties of the economic variables of primary interest – the prices received by cotton farmers, the quantity and quality of cotton produced and sold, and the costs of cotton production.

(3) The method developed for tailoring county-level rates to individual cotton producers makes no sense. Indeed, if a given farmer realizes an average yield, coefficient of variation, and average profit margin that equals the corresponding value of the county in each case, then the premium rate for COP will be zero at all coverage levels. The complexity and convo-

luted nature of the documentation for COP nearly masks this ridiculous and highly undesirable property of the COP plan of insurance.

(4) The NATMOD model generates deterministic pseudo-prices, given crop production. These pseudo-prices do not correspond in any way to the actual market for cotton for the following reasons: (a) Market prices are random not conditionally deterministic. (b) The stochastic properties of agricultural commodity prices are not determined only by realized U.S. crop production, as is assumed in NATMOD. (c) The market processes that generate market prices, exchange rates, demand, and other important economic phenomena are generated as the result of simple constant elasticity (that is, log-linear) relationships like those contained in NATMOD. The documentation does not provide any verifiable information on the predictive, explanatory, or econometric properties of NATMOD. A well-understood and widely accepted conclusion in the agricultural economics and applied econometrics professional literature is that simulation models like NATMOD perform extremely poorly in these dimensions.

(5) The method for deriving the pseudo-distributions for farm-level cotton yields from the NASS and RMA data sets is bizarre, *ad hoc*, and untested. The rates produced by the simulation process do not represent actual experience or the characteristics of agricultural production or market price determination.

Response to specific questions in the work order

(1) Protection of producer's interests

(A) Does the policy provide meaningful coverage that is of use to producers, and does it provide it in a cost-efficient manner?

No.

It is unclear whether the coverage is meaningful. The policy is marketed as cost-of-production insurance. In fact, it is a restrictive form of revenue insurance. The cost efficiency of the policy is unclear. The provisions are complex, and the simulation study used to compute rates is heavily dependent on simplifying assumptions, most serious of which is the implicit assumption that the stochastic processes which govern indemnity payments is exogenous to the presence of coverage. Further, the simulation methodology is unconventional and untested. It is entirely plausible that producer response to unrecognized moral hazard problems in the plan will drive the claims process in the direction of a higher loss cost ratio than is estimated under the exogeneity assumption.

It is also unclear whether the rate structure favors the producer, the insured, or neither. More generally, it is impossible to determine what constitutes cost efficient rates for this type of coverage.

(B) Is the policy clearly written such that producers will be able to understand the coverage they are being offered? Does the policy language permit actuaries to form a clear understanding of the payment contingencies for which they will set rates? Is it likely

that an excessive number of disputes or legal actions will arise from misunderstandings over policy language?

No.

The COP plan of insurance is a highly complex product. The indemnity formula is convoluted and cannot be described in terms of a straightforward reimbursement for a shortfall of revenue below a given level. AgriLogic has gone to great lengths to avoid various possible known sources of adverse selection and moral hazard, but this has complicated to COP plan and rating mechanism comprehensively. Given the complexity of the coverage and the difficulty in determining whether the coverage is cost of production or revenue insurance, it is unclear if producers will be able to understand the coverage they are being offered. Reporting requirements for filing a claim are complex and subject to interpretation, and thus are likely to give rise to frequent disputes and possibly even legal actions.

(C) Is the mechanism for determining liability (i.e., the amount of coverage) clearly stated and supported by an example?

No.

The documentation primarily implies that liability is based on the actual production expenses that are reported by the producer in the event of a claim. But the premium rates appear to be based on an assumption that these reported amounts will always be equal to the caps imposed by the policy provisions. It is unclear which of these will define the true liability levels under what circumstances, and it ultimately is left to the

adjustor to determine whether or not an accurate and honest reporting of production expenditures has been made on a case by case basis.

An example is given in the underwriting manual.

(D) Is the mechanism for determining the amount of premium clearly stated and supported by an example?

No. and Yes.

The way in which premiums are calculated is terribly unclear. Please refer to the detailed discussion in this report on pages 4-20 for a detailed discussion of the vagaries and problems associated with the premium rating and documentation.

However, an example is given in the underwriting manual.

(E) Are the mechanisms for calculating indemnities clearly stated and supported by an example?

No.

It is not clear whether indemnities will be calculated and paid on the basis of the stage of production – e.g., before planting, after planting but prior to harvest, post harvest – or on the basis of the precise time that the producer determines that he has experienced a loss. The policy provisions require notification within 72 hours of the discovery of a loss by the producer. But this seems to me to be completely unenforceable. There also is a difficulty with the way in which production expenses can be allocated across different crops and/or other production activities on a given farm in the event of a claim.

It therefore would seem that one needs to assume that the expense caps will be the level of expenses claimed in each and every case. This certainly seems to be the case in my understanding of how the rates are calculated.

Matters would be much clearer and substantially simpler if the COP plan of insurance were defined in terms of county-level average production cost caps at the end of each stage of production and permitted claims only at the end of each of the three stages listed above. Premium rates could be calculated in a more direct fashion. Reporting and verification requirements would be reduced to quantities transacted and prices received. This would seem to be a much more prudent method to define this type of revenue insurance.

(F) In the case of price or revenue policies, are the mechanisms for establishing price clearly stated?

No.

Although it is not designated as a revenue policy, COP insurance is a restrictive form of revenue insurance, and price accordingly plays a role in determining indemnities. The mechanisms for establishing the pseudo-market prices in COP are clearly stated. However, these price calculations are inconsistent with the underlying stochastic processes that determine actual market prices. In particular, in COP the price of cotton is perfectly correlated with cotton production. The only source of price uncertainty in this insurance product is due to the random variation in cotton yields. This is well-understood to be a false hypothesis.

(G) Is adequate, credible, and reliable data available for establishing effective market prices for insured commodities? Is it likely that the data will continue to be available? Is the data vulnerable to tampering if the proposed policy is approved? Is the data likely to be available when needed? Is the proposed system for publishing prices feasible?

No.

The data used to calculate the COP insurance rates are not based on actual market prices or cotton production. They are the result of an artificial deterministic simulation model – a model that is not based on any outcomes observed in the real world market for cotton. Therefore, these pseudo-prices can only be taken as suggestive of market prices which might result if this model were a true and correctly specified. It is not at all clear how the ratemaking method would adjust to reflect actual experience.

Neither the simulated prices used to produce the insurance rates nor the actual prices received by cotton producers are central market prices quoted on any public commodity exchange. This could lead to some risk of fraud in price reporting.

(H) Does the policy avoid providing coverage in excess of the expected value of the insured crop?

Yes, to the extent possible for this brand of revenue insurance.

(I) Does the policy contain indemnity or other provisions that cannot be objectively verified by loss adjusters, underwriters, or auditors?

Yes.

The policy imposes considerable self-reporting requirements which may be burdensome to producers, and which may open the door to a combination of high monitoring costs and potential fraud.

(J) Is the policy likely to treat all similarly-situated producers the same?

Not necessarily.

The problem is that the rates are based on a complicated and untested adjustment of pooled rates to individual producers. It is entirely possible that similarly-situated producers in different rating districts will pay different rates due to differences in the complex interaction between pooled rates and the individual adjustment procedure in the two cases. Scant evidence is given to support the ability of the producer-level adjustment procedure to deliver the same rate to similar-risk producers in different rating districts.

(K) Will insureds be able to comply with all requirements of the policy?

Probably not.

The reporting requirements are extremely burdensome. Due to incentive problems, it is likely that insured producers will not comply with the requirement to report losses within 72 hours of discovery. The detailed records required to isolate fuel, fertilizer, labor costs, and many other farm expenditures by crop and by period are unlikely to be kept on a regular basis by most producers.

(L) Will insureds be able to comply with all requirements of the policy?

Possibly, with a sufficient expenditure of time and effort.

(M) Is the product likely to adversely affect the agricultural economy of the crop that is proposed for coverage, or of other crops or areas?

Yes.

The subsidies built into the product are likely to elicit a supply response. In addition, it is demonstrated in the analysis and discussion on pages 4-20 of this report that the "typical" producer in each county will be charged a zero premium at all coverage levels. Thus, producers will be tempted to assume production risks which will be protected by the insurance but which would otherwise be unprofitable to undertake. If the associated supply response is sufficiently great, overproduction of cotton and related negative consequences on the market for cotton, producers of other crops, and the agricultural environment may result.

(2) Actuarial soundness

(A) Is adequate, credible, and reliable rate-making data available? Is it likely that the data will continue to be available? Is the data vulnerable to tampering if the proposed policy is approved?

No. No. Yes.

Please refer to the discussion and analysis on pages 4-20 above for a detailed explanation of the weaknesses in the COP data generation and rating methodology.

(B) Are the explicit and implicit assumptions used in the rating process reasonable?

No.

See pages 4-20 above for details.

(C) Are the technical analyses (e.g., stochastic and other simulations) technically correct? Do they provide credible, relevant results?

No.

See pages 4-20 above for details.

(D) Is the data used for the analyses appropriate, reliable, and the best available?

No.

See pages 4-20 above for details.

(E) Does the actuary certifying the submission's rates provide adequate and accurate support for the certification?

No.

There are two key problems:

(1) The assumptions necessary to perform the simulations; and

(2) The assumption of exogeneity of production to the coverage choice.

(F) Does experience from prior years and relevant crops and areas support the validity of

the proposed rates?

No.

There is no prior experience with COP or a sufficiently similar plan of subsidized revenue insurance for crop producers.

(G) Is the product likely to be sold in a sufficient number such that actuarial projections would be credible?

No.

Selling a large volume of COP insurance is unlikely, given its complexity. Moreover, a large volume of sales is unlikely to confirm the "credibility" of the given actuarial projections, since they have so many logical and methodological weaknesses.

(H) Does the submission increase or shift risk to another FCIC-reinsured policy?

No.

(I) Are the proposed premium rates likely to cover anticipated losses and a reasonable reserve?

No.

Please refer to pages 4-20 above for a detailed explanation.

(3) Other review areas

(A) Does this policy provide coverage that, in whole or part, is generally available from

the private sector?

No.

There is no private cost of production insurance.

(B) Does the policy propose to insure a peril that is not authorized by the Act?

No.

Cost of production insurance is specifically authorized in the Act.

(C) Does the policy place an unreasonable administrative burden on the insureds, AIPs, or the Federal crop insurance program? Mention reporting requirements of insureds, monitoring requirements of Federal crop insurance program to uncover fraud.

Yes.

The COP plan of insurance is a highly complex product. The indemnity formula is convoluted and cannot be described in terms of a straightforward reimbursement for a shortfall of revenue below a given level. AgriLogic has gone to great lengths to avoid various possible known sources of adverse selection and moral hazard, but this has complicated to COP plan and rating mechanism comprehensively. Given the complexity of the coverage and the difficulty in determining whether the coverage is cost of production or revenue insurance, it is unclear if producers will be able to understand the coverage they are being offered. Reporting requirements for filing a claim are complex and subject to interpretation, and thus are likely to give rise to frequent disputes and possibly even legal actions.

(D) To the extent of the reviewer's knowledge, does the policy comply with all requirements of the Act and the public policy goals of the Corporation?

Yes, to the best of my knowledge.

Supplemental Review Questions from Board Members

(1) Changes in itemized variable expenses more than 20% must be reported. During any given year, these expenses can vary greatly depending upon climatic conditions and unexpected major mechanical problems. This is a severe handicap to make adjustments to the insurance policy with the agent who may be hundreds of miles away during a high stress time of the growing season. Failure to report in time may result in loss of insurance, which probably will be discovered only at claim times. Remember this is the outline for future COPs for other crops. Cotton is a very low growing expense crop with limited expense items compared with many specialty crops. In specialty crops these numerous expenses can change very rapidly depending on the unique or unusual growing conditions in any one year. One wonders which agents and companies are going to be able to keep track of all this extra paperwork and whether or not problems will arise during claim times.

The individual reporting requirements create a temptation to falsify expenses in a manner which increases indemnity payments. The administrative cost created by these reporting requirements will be considerable, and provide incentive for companies and their agents who are responsible for record keeping to cut corners. Since cotton is a relatively low growing expense crop, these problems are likely to be exacerbated if the COP program is adapted to specialty crops with more complicated or variable production expenses.

(2) Pay close attention to the APH x price ceiling cap. All farmers who have had a disaster year (or years) are heavily penalized with amount of coverage + higher premium rates. Will this cause economic micro shifts in production due to availability for operating loans when loans may be evaluated on coverage amounts? Remember that one bank controls the majority of operating loan funds.

Ideally, the premium calculation would utilize an estimate of farm-level average yield which was not unduly affected by recent experience. Given the volatility in yields, the farm-level APH is a noisy indicator of the farm-level average. Extreme sensitivity to a single disaster year is inherent with premium calculations which rely directly on farm-level APH yield over a limited time period.

This problem could be addressed in principle by devising an alternative approach to estimating the farm-level average yield which takes into account the high level of spatial correlation in crop yields. Such a method would base the estimate of a particular farm's average yield on a spatially-weighted average of own-farm and surrounding-farm yields, with more weight given to farms in closer proximity. The method would need to be carefully designed to avoid undue sensitivity to recent experience which is not representative of prospective expectations.

(3) Does this insurance offer any more coverage than other plans already available? Previous studies show rare instances for this model to do as much. Usually recovery is less. Less insurance cost does not mean better coverage.

A key conceptual distinction between this coverage and its key rivals, APH yield insurance and CRC, lies in capping the liability with the level of actual expenses incurred. In principle, with COP insurance, a crop failure at mid-season would result in an indemnity no greater than the ex-

penses paid to date. Compared to equivalent coverage without the expenses-to-date cap on liability, the expected indemnity should be lower with a correspondingly lower premium.

Whether this is a desirable feature requires careful consideration of scenarios where losses are high and accrued expenses are low. It appears that there are cases where the indemnity paid would be low relative to the loss of anticipated income. On the other hand, there may be producers who would prefer to only purchase coverage up to their level of accrued expenses, if it were more affordable.

(4) Due to data needed for policy to determine standard expense ceiling, the policy may be severely limited to few areas that will have adequate 3rd party (excluding banks with conflict of interest) information.

This gets back to the issue of burdensome reporting requirements, and the implied balance of fraud risk and high monitoring costs. Careful consideration should be given as to whether it will be possible to effectively administer the self-reported expense ceiling imposed by the policy, and to what extent the various parties to the coverage (insured, insurance company, taxpayer, etc.) will bear the cost of this feature.

(5) The past 15 year history has shown sale price decline and inputs quickly increasing with overall production steady or rising ever so little. In the future will this insurance become less attractive than currently?

Basic economic principles suggest that introducing a program of subsidized insurance could result in at least two types of market distortion which could change the attractiveness of this type of coverage through time:

(a) Since the subsidies represent a percentage of the cost of insurance, the largest subsidies will accrue to the producers who pay the highest premiums. If actuarially fair, these premiums represent the expected payout from the plan. The coverage will inadvertently favor the production segment which generates the highest level of risk by paying a correspondingly higher share of premium subsidies. Subsidies generally have the effect of stimulating production, and in this case, the greatest incentive to increase production will impact the areas or practices with the highest level of risk.

(b) If the insurance was widely adopted and the premium subsidy elicited a significant supply response, downward pressure on prices would ensue. The unintended result over time could be a death spiral where low-risk producers would be unable to profitably operate, and high-risk producers could only maintain profitability by capturing the subsidy benefit conferred by the excess of indemnity payments over the after-subsidy premium level.

(6) This cotton policy has failed earlier due to inadequate coverage. This version only begins to fulfill by inserting subsidies into price. As a model for future crops what happens with crops with no supports? Are we putting ourselves into favoritism or worse? Why not build a data bank on cost by region for crops and build the insurance around it? As it stands now are we defeating the purpose why the term Cost of Production is even stated because revenue is the governing factor?

This could reduce or eliminate the burdensome reporting requirements previously discussed. Assuming the goal is to provide insurance to efficient producers, some benchmark of costs for an efficient producer could be established based on regional growing conditions and this could be

used to establish premium rates and indemnity provisions which would not require farm-specific year-to-date expense reports.

The review by Skees and Barnett discusses the inherent problems with offering true cost of production insurance. Basically, the cost of production is a choice variable of the producer, and hence is not insurable. As both of the key determinants of revenue, namely price and yield, are subject to external risks beyond the control of the producer, an insurance program based on realized revenue is somewhat more defensible than one which reimburses the producer for a cost overrun. Nonetheless, the fact that producer choices can potentially influence production expenses, realized yield, and sale price (and the reporting thereof) all suggest that moral hazard may potentially arise when revenue and production expense enter the indemnity formula.

(7) Is the cost worksheet misleading when it lists harvest costs which can be made up primarily of fixed equipment costs? Is this term meant only to reference custom harvest charges?

It appears that the harvest costs here can be custom harvest charges, or the variable costs of labor, fuel, and other immediate variable costs directly related to harvesting the cost, or both.

(8) Variable costs are supposed to be capped at 125% of county average. This is not explicitly included in the policy provisions, but rather is calculated and placed in the actuarial documents. Does it appear that producers will understand this 'implicit' cap?

In general, hidden restrictions on coverage should be made explicit in the communication of the policy provisions to producers. Failure to do so invites misunderstanding and recrimination in the event of a claims dispute.

Supplemental Review Questions from RMA

1. Could the proposed COP incorporate stages that were not based on production-expense data?

In principle, indemnities could be subject to a percentage reduction which depended on the stage of the growing season for the region in which the producer was located.

2. How would this affect the insurance plan in terms of ease of administration?

The objective would be to reduce or eliminate farm-level expense reporting, and the associated administrative burden and fraud risk.

3. Are producers likely to react positively or negatively to the presence of stages in the proposed COP plan?

The plan as currently proposed implicitly prorates the indemnity for the amount of expenses accrued at the time a claim is triggered. This appears to play a similar role as would the use of stages, except that there is a burdensome reporting requirement in the case of the proposed COP insurance policy. If incorporation of stages reduced reporting requirements without changing the fundamental nature of the coverage, it would appear to be more attractive to producers.

4. Would the premium rates produced by the individualized rating system for COP versus the APH-based rating system for other plans have any negative effect on the actuarial performance of the other plans or FCIC in general?

5. Are the individualized rates produced by the proposed COP rating model credible?

Given that the individualized rates are based on an untested and ad hoc adjustment procedure to

the county base rates, their credibility is questionable.

6. Production-expense data is used in the proposed COP plan for the following purposes:

a. Insurance Guarantee -- Limit the maximum amount of insurance available when reported production expenses are less than the expected gross income (EGI).

b. Insurance Indemnity -- Reduce loss payments when actual production expenses are less than the Approved Expenses.

Does the incorporation of production-expense data serve any other function or provide any other benefit in the proposed COP plan?

The conceptual purpose for incorporating production-expense data as a limit on coverage is to restrict the liability and indemnity payments to the actual amount of expenses incurred up until the occurrence of an indemnified event. If properly rated, this coverage should be less expensive than coverage without the production expense limit on indemnity payments and coverage level.

7. When its pilot programs contain unusual or controversial features, FCIC sometimes requires that applicants sign a "disclaimer" at the time of purchase. These disclaimers contain a statement whereby the producer acknowledges that the unusual/controversial features exist and that she/he understands and accepts them. Such forms are used to promote a thorough discussion between the agent and the producer before the sale is completed, thereby reducing the probability of angry feelings at loss time. A draft disclaimer for COP, which highlights four features, is included at the end of this Appendix. Should FCIC require COP applicants to sign this or a similar disclaimer? If so, are there other components that should be included in the Disclaimer?

The use of a disclaimer to promote a thorough communication of policy features by the agent to the producer seems useful for precluding later claims disputes. However, the wording of the first two points on the draft disclaimer is overly vague, and may have the unintended consequence of making producers wary of participation.

8. Can this assumption of normality within a quintile in the NASS yield data be safely made?

The appropriateness of the normality assumption is an empirical question which cannot be tested with the data used by AgriLogic. In general, the normality assumption is used more as a matter of analytical convenience than as a literal description of yield experience. The problem is that crop yields are often subject to serious departures from normality, such as significant negative skewness and excess kurtosis, which could result in higher loss cost ratios than would be estimated under the normality assumption.

A second unsupported assumption underlying AgriLogic's method of estimating yield distributions is that the quintile ranking by average yield creates a meaningful partition of the data into risk classes. If there is little relationship between coefficient of yield variation and average yield, then the data grouped within each quintile might represent a broad range of risk characteristics. The average coefficient of variation within each quintile, which is used to construct the estimated yield distributions, may mask the more extreme end of the risk spectrum of producers. Given that the riskiest producers are likely to generate a large majority of claims, it is likely that the procedure delivers rates which underestimate the cost of coverage.

9. Is there a more appropriate assumption that could be made to generate the set of producer data?

Unfortunately, the data utilized does not appear to be adequate to infer the joint distribution of yield and price which drives the indemnity process. The statistics on which the estimated yield distributions are based, namely the median of producer averages and the average of producer co-efficients of variations, provide little information about the actual pattern of yield variation at the farm level, and no information about the joint variation in yield and price which determine variation in revenue.

From the description of the simulation methodology, it is not clear how or whether the statistical relationship between price and yield was taken into consideration. The description of the NATMOD econometric model suggests that price was treated as a deterministic quantity, rather than a random quantity which contributes risk to the coverage.

10. Is this adjustment reasonable?

The adjustment is ad hoc, and does not correct the basic problems with the methodology, which are the complete lack of any evidence of the suitability of the normal distribution, and the failure to consider the essential role of the random relationship between price and yield in determining indemnities.

11. Is this adjustment constrained by the spatial variability that existed in 1997?

The methodology does not appear to account for the role of spatial variability.

12. This data set is the basis for all rate calculations. Do these data simulation adjustment procedures generate a set of good data for the purposes of rating?

The points raised above call into question the suitability of the generated data for rating pur-

poses. In addition, the simulation cannot account for possible producer

13. Is there a better data set that could be used for the rating of this product?

Comments in the white paper suggest the simulation utilized all available data, so perhaps the question is moot. Given the potential for the product to inadvertently provide incentives for un-anticipated changes in producer behavior, it is probably not possible to use historical data in the absence of coverage to predict the cost of providing coverage. However, at a minimum, a suitable data set would need to include information about the joint variation in farm-level yield and price.

14. Is it appropriate to calculate the premium as the weighted average of three independent functions of profit margin, average yield, and coefficient of variation of yield? In other words, are these functions actually independent?

Average yield and coefficient of variation of yield are necessarily dependent, as the coefficient of variation is defined as the ratio of the standard deviation of yield to the average yield. So, for instance, if producers 1 and 2 have the same standard deviation of yield, and producer 1 has a higher average yield than producer 2, then producer 1 necessarily also has a lower coefficient of yield variation than producer 2.

Profit margin is also likely to be statistically dependent on average yield. If producers 1 and 2 have the same production costs, and producer 1 has a higher average yield than producer 2, then producer 1 will also have a higher average profit margin than producer 2.

The method of individualizing county base rate to a producer level is ad hoc, complicated, and untested. It is unclear how the respective weights on the differences in mean yield, coefficient of

variation of yield, and mean profit margin are derived from the correlations with LCR. The assumption of a linear relationship between these differences and the producer-level base rate is unsupported by empirical evidence. Given the likely presence of a nonlinear relationship between the variables used in the adjustment and the true, but unobservable, farm-level base rate, the method could perform poorly. There is no mechanism in the ratemaking methodology to test or adjust the assumed relationship of farm-level base rates against the evidence of accumulated experience.

A Brief Discussion of the Previous Reviews

(1) John Pierce

Mr. Pierce questions the validity of the method of creating individual by-producer rates from county Base Rate and argues that the method used by AgriLogic for this purpose gives too much weight to individual producer experience. In fact, the method of individual adjustment is ad hoc, and with little to no useful evidence provided to support its validity.

Mr. Pierce also questions the credibility weighting procedure. This again is ad hoc and judgment based, with little evidence – theoretical or empirical – to support its validity.

Although Mr. Pierce is an actuary, he expressed difficulty with understanding the policy wording. I agree that the policy provisions are sufficiently complicated that a typical actuary, underwriter, or statistician will find it difficult to interpret. This complexity is likely to overwhelm a producer considering participation.

Mr. Pierce points out in that the ratemaking data are not based on any actual experiences in the market for cotton. We can add to this the fact that the simulated data are not representative of what could reasonably be expected to be observed in the market for cotton, with or without COP. We cannot know what will happen if the plan is implemented, except that costs are likely to be higher than what are estimated assuming exogenous production practice. It is in the interest of producers to discover and exploit changes in production practice which increase the return to insurance, and given the complexity of the plan, it is quite difficult to anticipate such changes in advance.

- The current submission does not address <u>any</u> of these important and substantive concerns

raised in the previous review by Mr. Pierce. In this report, I have identified and further elucidated the nature and severity of these issues. Without a substantial redress of these issues, there can be no justifiable basis for approving this product.

(2) MBA, Inc.

MBA takes issue with reliance on the NATMOD model, its costs, and its relation to the proposed coverage. The simulations conducted by AgriLogic rely entirely on cotton yield variations to generate different market prices for cotton. This exercise simulation is deterministic. There is no avenue for price uncertainty given the NATMOD framework. The simulated pseudo-prices for cotton are assigned to historical yield data, which are then used attach determine revenue outcomes over the historical period. This procedure does not appropriately control for price risk. It also is unclear how the NATMOD model would be used going forward.

- As in the case of the previous review by Mr. John Pierce, the current submission does not address any of these substantial and serious issues with the COP rating methodology.

(3) GlobalAgRisk, Inc.

GlobalAgRisk provides a concise description of the indemnity formula. This description helps to reveal the considerable complexity of the policy provisions. GlobalAgRisk also notes that the COP coverage is not true cost of production insurance, but rather is a form of revenue insurance subject to certain restrictions. Examples of the hidden moral hazard incentives in the COP plan are provided. These incentives are triggered over different stages of the cotton growing season. Finally, GlobalAgRisk argues that the reporting requirements under the COP plan are burdensome and the possibility of fraud is a considerable concern.

- The adverse selection, moral hazard, and potential fraud problems inherent with COP are serious and a major defect of this type of insurance product. AgriLogic has gone to great lengths to identify and correct several of these incentive problems in the current version of COP. This greatly increases the complexity of the reporting requirements for producers, the monitoring and verification requirements on adjustors, and the calculations of premium rates for the FCIC. Even with these extreme efforts and the additional cost and complexity of implementing the COP plan of insurance, moral hazard, adverse selection, and possibly even fraud can not be completely eliminated or overcome. They are an unavoidable attribute of attempting to provide crop insurance with the guarantee determined by the insured producer's self-reported actual cost of production and the level of the indemnity payment determined by the insured producer's self-reported actual revenue.

(4) Sparks Companies Inc.

Sparks, Inc. mainly characterizes COP as an intermediate option between inexpensive but incomplete coverage under MPCI APH yield insurance and the richer but more expensive CRC coverage, arguing that CRC is only advantageous when prices are relatively high early in the growing season and expected to decline substantially by harvest time.

(5) Thomas Knight

The key points raised by Professor Knight are that the rates do not adequately consider the percent of expected gross income insured and the use of cross-sectional data to develop producer-level yield distributions and premium rates.

- These issues remain a serious concern, and have not yet been adequately addressed in the

current submission. This report discusses the nature and significance of these problems at length. Absent a substantial change in way that rates are calculated for COP, this proposal should not be accepted by the Board.

Additional problems with the COP plan of insurance

(1) The proposed COP coverage will interact with and complicate other government subsidy programs for cotton and other crops for which the product ultimately is implemented. At this stage it is impossible to determine to what extent insured producers, COP insurance providers, and taxpayers gain or lose. Given the level of subsidy in the premium rates, producers for whom rates are correctly determined can benefit by reporting production costs at least equal to the expected revenue ceiling because this maximizes the expected return in claims from the plan.

(2) Given the complexity of the reporting and monitoring requirements of COP in the event of a claim, it is doubtful that insurance adjustors will be able to do more than cross check the reported expenditure against the corresponding ceilings provided in the policy provisions.

(3) The premium subsidies, the use of the cost of production to define the guarantee for the insurance, and the lack of any proper allowance for price uncertainty in the COP plan of insurance will result in two critical economic effects. The first is that there will be a supply response. The initial impact will be acreage shifting away from crops not eligible for COP or a comparable subsidized insurance product. We are beginning to experience substantial acreage shifts in some areas of the country towards crops with subsidized revenue insurance products. As this supply response persists, market prices will decline. The second expected impact is that the value of farmland and other specialized fixed assets in cotton production

will be bid up, increasing the average total cost of production. The combination of falling market prices for cotton and rising production costs may well lead to financial difficulties for the COP program, higher costs of other governmental programs such as the marketing loan program, and the expected revenue cap being binding at all times because it is significantly lower than production costs. These are all highly undesirable economic outcomes.

(4) In general, the objectives underlying the catastrophic loading procedures are not clearly defined. Evidently they are related to balancing the goal of sharing the risk of large idiosyncratic losses at the county level across a broader geographic area against the risk that pooling and redistributing catastrophic losses across a broader area will result in unintentional cross-subsidization of low risk groups by high risk groups.

Absent any crop price risk, the loss cost ratio depends on the sum of indemnities paid across farms within a given county, which in turn depends on the truncated lower tails of the yield distributions across individual farms. The proper point of departure for modeling loss cost ratios, therefore, is first to model the spatial and temporal distribution of crop yields and then to build in the dependence of the loss cost ratio on yield. The correct way to proceed in this regard would be to calculate the mean yields for each county in each year as, e.g., a (possibly nonlinear) trend, perhaps as has been done in the COP proposal, and then to evaluate the deviations from that trend as the random variables of fundamental interest. These residuals will have a correlation structure across counties, or other locations in space, as well as through time, which is readily estimated using standard statistical methods.

One part of a given county's yield residual will be correlated with those of other counties, or perhaps with the statewide, region wide, or nationwide average yield residual, or other

desired level of spatial aggregation. The common part reflects the pooling component of the insurance premium. The remainder is idiosyncratic and uncorrelated with other residuals. The idiosyncratic part reflects the specific component of the premium.

The correct method to determine a properly defined risk region, within which to pool the common parts of the yield risk, is to construct region boundaries where the cross-county correlation between yield residuals is small, or statistically negligible.

In good years, it is conceivable that no farms in a given county will be paid indemnities. In bad years, crop yield correlations due to weather or other widespread hazards implies a possibility that numerous farms incur yield losses. The statistical distribution for the loss cost ratio depends on that part of the joint crop yield distribution over space and time for farmers who have incurred losses large enough to receive indemnity payments. Directly modeling the joint crop yield distribution, including the statistical dependencies among yields across space and time, avoids unnecessary errors in calculating the distribution for the loss cost ratio and the catastrophic loss component of that distribution. In principle, the catastrophic loading procedure should incorporate features which track gains or losses due to cross-subsidization between counties in the methodology and systematically correct the catastrophic loads for these sources of bias over time. These features are not included in the proposed method for rating COP. If the actuarial judgment underlying the various *ad hoc* features of the COP procedure can not be validated through experience, there is no scope for eliminating bias in the catastrophic load. An accurate model of the statistical distribution of loss cost ratios is essential to the performance of catastrophic load procedures. The proper starting point is a statistical analysis of the stochastic process generating yields over space and time.

(5) What is the meaning of a ***reasonable reserve*** in the case of a taxpayer subsidized federal crop insurance plan? This concept makes sense in the case of private insurance plans, where the reserve in excess of actuarially fair liability provides a cushion in the insurance fund to self insure against insolvency. But in the case of tax-payer funded federal crop insurance, there is no insurance fund and the purpose of the reserve is unclear. This is especially true in the context of FCIC provided reinsurance of up to 50 percent of the total premiums for the private insurance companies that agree to sell COP.