Crop Insurance Reserving

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Abstract: The crop insurance industry is a private-public partnership, whereby the private companies issue policies and handle claims for multi-peril crop insurance policies, which are administered by the U.S. Department of Agriculture-Risk Management Agency. The private companies are reinsured by the Federal Crop Insurance Corporation under the terms of the Standard Reinsurance Agreement. Private companies also issue insurance policies not administered by RMA, which provide additional cover, typically referred to as "Crop-Hail."

Crop insurance is a short-tailed line of business; however, significant variation to the ultimate loss ratio exists on an annual basis. Reserving for crop insurance is unique due to the characteristics of the crop insurance policy and catastrophic nature of the risks: weather and price changes. This catastrophic risk is mitigated due to reinsurance from the Federal Crop Insurance Corporation. This paper presents methodology to estimate ultimate losses and reserves for crop insurance.

Keywords: Crop Insurance, Short-Tail, Catastrophe Reserves, Crop Hail

1. INTRODUCTION

Crop insurance is typically viewed as a short-tailed line of business as regards to reserving for ultimate liabilities. Since crop insurance provides coverage for both yield and price risks for a growing season, the annual results will exhibit significant volatility due to the catastrophic nature of weather, as well as price changes. The process for insuring farmers for the revenue risks associated with crops and livestock has been evolving, and the introduction of new policies has changed the calculation of the indemnities to the farmers in the event of loss. This paper addresses the exposures associated with crop insurance and discusses methodologies to estimate ultimate loss ratios and unpaid claim liabilities for these exposures.

The remainder of the paper proceeds as follows. Section 2 will discuss the background of crop insurance from a historic point of view. The underlying exposures such as crops, prices and insurance plans will then be discussed with the implications to forecasting ultimate losses. This will be followed by a discussion of the public-private partnership and the Standard Reinsurance Agreement (SRA). Finally, the accounting treatment of crop insurance is presented. Section 3 will discuss the methodologies and issues of forecasting losses associated with crop insurance. This section will include various pitfalls with traditional loss reserving methods that would apply to crop insurance.

Section 4 will discuss the conclusions of this paper and future areas of additional research.

2. BACKGROUND AND DISCUSSION OF INSURANCE PLANS

2.1 History

Prior to 1938, attempts by commercial insurers to write crop insurance were not successful due to low participation and lack of credible data, as well as the catastrophic nature of the risk. The federal crop insurance program was established in 1938 with the passage of the Federal Crop Insurance Act. The Federal Crop Insurance Corporation (FCIC) was created in 1938 to carry out the program. Initially, the program was limited to major crops in the primary producing areas and was considered mostly experimental. The Federal Crop Insurance Act of 1980 expanded the crop insurance program to many more regions of the country and encouraged more participation by offering a 30% premium subsidy.

While the participation increased during the 1980s, a major drought in 1988 led to an ad hoc disaster assisstance program that was authorized to provide relief to farmers. Additional disaster bills were passed in 1989, 1992, and 1993. The concern that the availability of federal relief in the event of a disaster served to reduce participation in Federal Crop Insurance led to the enactment of the Federal Crop Insurance Reform Act of 1994. This Act made participation in Federal Crop Insurance mandatory for farmers in order to be eligible for deficiency payments under price support programs, certain loans and other federal farm assisstance programs. A policy providing limited coverage was introduced called catastrophic (CAT) coverage, which was available for a nominal charge. Subsidies for additional coverage were increased. The Risk Management Agency (RMA) was created to administer FCIC programs and other non-insurance risk management and educational programs to support agriculture. Policies were introduced that incorporated price risk in addition to yield risk.

The Agricultural Risk Protection Act was passed in 2000, which increased insurance options and subsidies. Participation in revenue policies substantially increased. Partnerships between RMA and private entities were encouraged to develop new, innovative insurance products that covered additional crops, as well as livestock.

2.2 Crop Insurance Plans

A crop insurance plan provides protection to farmers due to loss of yield or revenue from insured perils. The majority of crop insurance plans is administered by RMA and is referred to as multi-peril crop insurance or MPCI. Private insurance plans are typically referred to as "Crop-Hail" and provide additional or gap coverage to MPCI. The following is a brief overview of many of the crop insurance plans. There are significant additional details and regulations for each plan that are beyond the scope of this paper.

2.2.1 Actual Production History

Actual production history (APH) plans were the primary policies issued prior to 2000. APH plans are the basis for most of the other policies so a detailed description of the APH plan will be discussed here and the differences of the other policies will be described later. RMA publishes bulletins and handbooks that should be referred to for any detailed issue regarding MPCI.

APH policies insure farmers against yield losses due to natural causes such as drought, excessive moisture, hail, wind, frost, insects, and disease. The liability of the policy is calculated as:

Acres Insured x Expected Yield x Coverage Level x Price x Share

Expected yield[1] is typically the latest ten-year average of yields. Coverage level (or deductible) is selected by the farmer and can be between 50% and 75% in increments of 5%.[2] Price is established by RMA before the beginning date of the policy based on expected harvest prices. The farmer can also select between 55% and 100% of the price – usually 100% is selected. Share is defined as the percentage of interest in the insured crop as an owner, operator or tenant at the time insurance attaches.[3] An example follows:

The following table displays a farmer's historical yield per acre for a hypothetical crop for an insured unit:[4]

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
60	55	64	68	25	72	71	15	78	72

1 The actual methodology to calculate the expected yield (or APH) is very detailed and is beyond the scope of this paper.
2 The maximum coverage level can be greater than 75% in various states for various crops.
3 USDA – RMA Final Agency Determinations "The Definition of 'share'" under 7 C.F.R. &457.8-Definitions.
4 RMA has established regulations how farmers can separate their crop fields into various units of insurance. The details are beyond the scope of this paper.

The average yield (or approved yield) is 58. Assuming the farmer selects a 75% coverage level, insures 100 acres[5] with a 100% share and the price is $4.00, then the liability equals $17,400 or:

Liability = Approved Yield x Price x Coverage Level x Acres x Share

or

$17,400 = 58 x $4.00 x 75% x 100 x 100%

For an APH policy, the trigger of a claim is whether the actual yield[6] is lower than the APH times the coverage level times the acres, or $4,350:

Guaranteed Yield = Approved Yield x Acres x Coverage Level x Share

or

$4,350 = 58 x 100 x 75% x 100%

Let's assume the farmer's yield is 2,250, then the indemnity would be calculated as:

Indemnity = (Guaranteed Yield - Actual Yield) x Price

or

$8,400 = (4,350 – 2,250) x $4.00

MPCI may provide for additional coverage such as replanting or prevented planting as well. Replant provisions cover the anticipated cost of replanting after an initial planting that doesn't produce a stand due to excessive rain or drought. Prevented planting allows coverage in an area where planting is not possible, typically due to wet fields. The farmer could collect an indemnity much smaller than the overall liability and plant a new crop with a lower coverage amount.

2.2.2 Revenue Plans

Participation in revenue plans significantly increased after the passage of the Agricultural Risk Protection Act of 2000. There are currently three plans that are similar to an APH plan, but include a provision for price risk as well. These plans are Crop Revenue Coverage (CRC), Revenue Assurance (RA), and Income Protection (IP). Unlike APH plans, where the same price that is used in determining liability is used in determining indemnity as well, the revenue plans use separate prices. Thus, in addition to yield risk, the revenue product includes an element of price risk. The spring price is established before planting and the fall price is established near harvest time. The basis for the prices is usually a monthly average of the crop's daily settlement value traded on a

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5 To avoid adverse selection, a farmer must insure all insurable acreage of a crop within a county.

6 This is referred as "production to count." In the event the insured acreage is not harvested, there are loss adjustment standards published by RMA to measure the yield.

exchange. For example, the December corn futures are traded on the Chicago Board of Trade (CBOT). The following table displays some of these futures and dates for the fall price[7]:

Crop	Insurance Plan	Future	Monthly Average
Corn – 3/15 Close	RA	December	November
Corn – 3/15 Close	CRC	December	October
Soybeans – 3/15 Close	CRC and RA	November	October
Soybeans – 2/28 Close	CRC	September	August

Using the APH example from above, assume that the spring price is also $4.00, but the fall price increases to $5.00. The liability is the same as in the APH example, i.e., $17,400.

Therefore the calculated revenue is the fall price times the production to count or:

$11,250 = 2,250 x $5.00

and the indemnity is

$6,150 = $17,400 - $11,250

Beginning with crop year 2011, RMA has combined the APH, RA, CRC and IP policies into a "Combo" policy. The insured would still have the option to exclude the price risk as the original APH plans do. RMA combined these programs to eliminate overlapping policies and reduce administration costs. The RA policy and the Combo policy include an option (for additional premium) where the guarantee (liability) uses the greater of the spring price or the fall price.

Using this option, in the example above, the guarantee (liability) would increase to $21,750, or:

$21,750 = 58 x $5.00 x 75% x 100 x 100%.

The calculated revenue would remain the same at $11,250, and the indemnity would increase to:

$10,500 = $21,750 - $11,250.

These options have been very popular, so special attention should be paid to years where the fall price exceeds the spring price.

7 Please note these dates can change. Refer to RMA for the actual method to establish Spring and fall prices.

2.2.3 Group Risk Plans

There are currently two insurance plans that use a county index as the basis for determining indemnity: Group Risk Plan (GRP) and Group Risk Income Plan (GRIP). Both plans use the county yield as determined by National Agricultural Statistics Service (NASS). GRP payments are made when the county yield in the crop year falls below the expected county yield for that year. The individual yield for the farmer is not a factor in this plan – other than any impact to the overall county yield. The farmer can only insure as many acres as they plant in the county of the same crop. The coverage for GRP is similar to APH, where the farmer selects a coverage level (up to 90%) of the county average and payments are made when the county yield is lower than the coverage amount.

GRIP includes price in this calculation, as well as yield, and bases indemnity on the expected county revenue versus the actual county revenue. The prices are currently established similar to the CRC plans. The insured can select, for additional premium, the Harvest Revenue Option, where the guarantee is the greater of the spring price or the fall price. The following table displays an example for these policies:

Insurance Plan	(A) Expected Yield	(B) Spring Price	(C) Expected County Revenue = (A)x(B) HRO Max (B) (D)	(D) Fall Price	(E) Actual Yield	(F) Actual Revenue = GRP = (B)x(E) GRIP = (D)x(E)	(G) Indemnity at 90% CL = Max {(C) x 90% - F,0}
GRP	100	$4.00	$400	N/A	75	300	60
GRIP	100	$4.00	$400	$3.00	75	225	135
GRIP-HRO	100	$4.00	$500	$5.00	75	375	75

Currently, the county yields and revenue are not released by RMA until April of the following year for corn and soybeans. Since payments are not made until mid-April, establishing a reserve for this exposure is necessary for year-end reserve analyses. A detailed methodology to establish these reserves is presented in a later section of this paper.

2.2.4 Dollar Plans

Dollar plans were introduced for crops that do not typically have an historical actual yield. There are essentially three different dollar plans currently administered by RMA. The first one is for some vegetable crops. The second plan covers nurseries. The third plan is a dollar tree plan, which insures perennial trees primarily in catastrophic prone areas.

The vegetable dollar plans differ from APH plans in the following ways:

- The historical farmer's yield has no bearing on the guarantee. The guarantee is set by county and is referred to as the maximum reference dollar amount.
- There are a lot of input costs during the season to produce a mature crop. Therefore, stage guarantees limit the amount of insurance coverage from planting to harvest. For example, after 30 days, only 50% of coverage is available.
- There is a significant cost of harvesting the crop, which is deducted from the overall acre guarantee. This is called the allowable cost.
- Causes of loss exclude disease or insect manifestation.

Nursery insurance is a unique coverage that insures the inventory of plants at the nursery. The plant inventory value is a measure of all insurable plants in the nursery. A farmer can insure a percentage of this value. Insured causes of loss include adverse weather conditions, fire, and wildlife.

Fruit tree insurance places a certain dollar amount of insurance on each tree depending on the type and age of the tree. Since many fruit trees are planted in hurricane-prone areas, wind is a major risk for this coverage. The insurance also covers excess moisture and freeze—but not insects, disease, or wildlife.

2.2.5 Rainfall and Vegetation Index

Rainfall Index (RI) and Vegetation Index (VI) are insurance plans introduced in 2007. These plans insure pasture, rangeland, and forage, and are based on rainfall and vegetation indices. A similar plan called Apiculture, subsequently introduced, insures honeybee colonies based on these indices. A farmer can choose to insure acreage used for pasture, rangeland and forage, or honeybee colonies for two or three monthly intervals throughout a year.

An indemnity is paid when the RI or VI is less than the coverage level selected. RI uses data from the National Oceanic and Atmospheric Administration Climate Prediction Center (NOAA CPC). The multiple data sets include weather, satellite, and radar data, and are interpolated and smoothed to 12 by 12 mile grids. The insurance is based off the index within each grid and not individual farms or ranches actual rainfall.

VI uses data from the U.S. Geological Survey Earth Resources Observation and Science data center called the Normalized Difference Vegetation Index (NDVI). The NDVI measures vegetation greenness to estimate plant conditions in approximately 4.8 by 4.8 mile grids. The healthier the plants in the grid, the higher the NDVI will be. Similar to the RI, farmers' own conditions are not considered in the indemnity calculation; only the index is considered.

2.2.6 Livestock Insurance

There are currently two livestock programs currently administered by RMA. Livestock Gross Margin (LGM) provides protection against the gross margin, which is defined as the market value of livestock (or dairy) minus feed costs. Livestock Risk Protection (LRP) provides protection against livestock price declines.

There are three coverages for LGM: Cattle, Dairy and Swine. The gross margin is calculated as the difference between the market price of the livestock (or dairy) and the cost of producing the livestock (or dairy). The insurance period is based on the time it takes to raise the livestock for market and the anticipated cost of feed during this time. Famers can insurer all livestock on a monthly rolling basis. For cattle and dairy, the insurance period is eleven months and for swine, it is six months. This represents the expected time from the beginning of the insurance to the time of selling the livestock. The prices are based on futures and adjusted for state and monthly specific basis. The actual cost of feed or livestock price to the famer is not considered in the indemnity calculation.

LRP is similar to LGM, but it excludes the price of feed in the indemnity calculation. LRP includes lambs, but does not include dairy.

These coverages are similar to GRIP in the sense that indemnity is based off price indices, rather than a farmer's actual revenue loss. However, private insurance can be used to insure the property (the actual livestock) and potential liability caused by their livestock.

2.2.7 Adjusted Gross Revenue

Adjusted Gross Revenue (AGR) insures farmers' overall net income from operations based on filed tax returns. The liability is calculated from previous years' tax returns and is adjusted for any changes in the current operations compared to previous years. Offsets are made for crops that are insured, since any indemnity would be considered revenue to the farmer. These plans are more popular with famers with a variety of operations of which some crops are insurable under MPCI and other crops are not. Examples include vegetable farmers in California or fruit growers in Washington. These plans are generally complicated and can vary significantly by farmer. The plans also pay out later in the following year so this exposure needs to be estimated at year-end for reserving purposes.

2.2.8 Private Crop-Hail

Private crop-hail insurance has been available in various forms since the early twentieth century. This coverage differs from a standard MPCI plan, in that it provides coverage on an acreage basis, rather than a unit basis. In other words, a hail storm could damage part of a field and the crop-hail would provide a payment for the acres that are damaged, whereby MPCI would only pay out if the total unit was damaged enough to lower the yield below the coverage level. Private crop-hail also pays out soon after the occurrence, whereas MPCI will wait until after harvest (unless there is a complete loss).

Private plans also cover wind, transport, and fire damage, both when the crop is in the field and after harvest. MPCI only covers the crop while it is in the field. A farmer can select to exclude hail coverage for the MPCI and receive a reduction in MPCI premium. Crop-hail may also provide replant coverage especially for crops that do not include this coverage in the MPCI policy.

2.3 Crops and Insurance Dates

This section discusses the important dates for MPCI and the implications of these dates. Since the payout of indemnity is typically made quickly after harvest or a major loss that destroys the crop, an understanding of these dates is critical in estimating unpaid claim liabilities. These dates should also be understood in conjunction with the SRA, since additional losses or gains may be primarily ceded to FCIC.

An example of insurance dates is shown for corn in Iowa.[8] These dates are similar for corn-belt crops other than wheat and other specialty crops. In the southern states, the dates are typically a month or so earlier.

Sales Closing Date – March 15: This is the final date that a farmer can sign up to insure crops.

Earliest Planting Date – April 11: This is the first date that a farmer can plant and the crop will be insurable. These dates are based on the climate and may vary by crop.

Final Planting Date – May 31: This is the latest a farmer can plant and still receive all of the coverage. The coverage decreases each day past the final planting date up to a certain date, when no insurance is provided. This is based on the climate and the days to maturity the crop needs before harvest.

Acreage Reporting Date – June 30: At the time of the Sales Closing Date, the farmer may not know what crops will actually be planted and on which fields when they initially sign up to insure crops. This can be based on many issues, including current weather and prices, the availability of land, the cost of seed/fuel/etc. Thus, the acreage reporting date is somewhat later in the year, when all crops have likely been planted. The famer must report what they actually planted (acres and crops) by this date.

Premium Billing Date – October 1: This is the date the farmer is billed for the unsubsidized MPCI premium. While outside the scope of this paper, the cash flows for MPCI differ from traditional property and casualty insurance. An escrow fund is established between the Approved Insurance Provider (AIP) and FCIC, which is used to pay premium, losses, A&O subsidy and the net underwriting gain determined by the SRA.[9]

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[8] 2009 Commodity Insurance Fact Sheet – USDA RMA

[9] Historical Rate of Return Analysis – Milliman, Inc. for USDA - RMA.

End of Insurance – December 10: According to the Iowa Fact Sheet: "Insurance coverage will end at the earliest of: (1) Total destruction of crop, (2) harvest of the unit, (3) final adjustment of a loss, (4) December 10, 2009 or, (5) abandonment of the crop."[10]

These dates are important when establishing ultimate loss ratios for each state/crop. It is also important to note that RMA may issue directives that modify these dates due to unusual circumstances.

2.4 Standard Reinsurance Agreement

The SRA is an agreement between the AIP and FCIC, whereby the AIP provides insurance to farmers and the FCIC reinsures the AIP. The FCIC also pays the AIP a percentage of premiums called A&O subsidy to pay for the administrative and operating expenses of the company. The reinsurance terms of the SRA are calculated on an annual basis for all crops and states. Within thirty days of writing the policy, the AIP assigns each policy to one of the SRA funds[11] for each state. Each fund has a different reinsurance structure in place, where some funds have little risk/reward and other funds have significant risk and reward. This is critical when estimating loss ratios (or underwriting returns) net of the SRA. There is a separate SRA for livestock insurance. The discussions that follow are regarding the MPCI SRA.

The SRA defines the net underwriting gain/loss as the difference between the retained net book premium and the retained ultimate losses. The net book premium excludes A&O subsidy, cancellations, adjustments and administrative fees. The net ultimate loss is defined as any claim paid by the AIP less any recovery or salvage.

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10 Iowa Fact Sheet.

11 There is a limit to the amount an AIP can place in the Assigned Risk fund by state. The excess amount automatically gets "spilled over" to the Developmental Fund. The AIP may also cede quota share an amount for each fund/state.

The following table displays each fund and the various retentions of underwriting loss/gain from the AIP's perspective for the 2010 SRA:

Gross Loss Ratio	Assigned Risk	DEVELOPMENTAL			COMMERCIAL		
		CAT	Revenue	Other	CAT	Revenue	Other
0%	2.0%	4.0%	6.0%	6.0%	8.0%	11.0%	11.0%
50%	9.0%	30.0%	50.0%	50.0%	50.0%	70.0%	70.0%
65%	15.0%	45.0%	60.0%	60.0%	75.0%	94.0%	94.0%
100%	5.0%	25.0%	30.0%	25.0%	50.0%	57.0%	50.0%
160%	4.0%	20.0%	22.5%	20.0%	40.0%	43.0%	40.0%
220%	2.0%	11.0%	11.0%	11.0%	17.0%	17.0%	17.0%
500%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Since the retention of underwriting gain/loss is calculated on an individual state/fund basis, there may be a significant difference between the gross loss ratio and net loss ratio. Due to the sharing of loss/profit by state and fund, it is important to model ultimate losses by state and fund. The following scenarios are shown to highlight the possible differences from the gross loss ratio to the net loss ratio. The following scenarios are provided where the gross loss ratio is the same overall, but differences in state/fund can significantly change the net loss ratio.

State	Gross Premium	Commercial Fund Allocation Percentage	SCENARIO 1		SCENARIO 2		SCENARIO 3	
			Gross Loss Ratio	Net Loss Ratio	Gross Loss Ratio	Net Loss Ratio	Gross Loss Ratio	Net Loss Ratio
IL	150	75%	100.0%	100.0%	13.3%	55.7%	200.0%	147.8%
ND	100	25%	100.0%	100.0%	20.0%	65.6%	20.0%	65.6%
TX	100	25%	100.0%	100.0%	340.0%	157.9%	10.0%	64.7%
WI	50	50%	100.0%	100.0%	40.0%	61.8%	140.0%	119.3%
Total	**400**	**47%**	**100.0%**	**100.0%**	**100.0%**	**74.6%**	**100.0%**	**117.3%**

These examples display why it is important to estimate loss ratios on a state/fund basis, rather than an overall gross and net loss ratio basis.

Beginning for the 2011 crop year, a new SRA was being negotiated between the FCIC and the AIPs. The major changes are:

- The number of funds would be collapsed into two funds: Assigned Risk Fund and Commercial Fund.
- The Commercial Fund would have three different groups (Group 1, 2, and 3) with different retention percentages based on the historical loss experience of the state.
- AIPs would be encouraged to write business in underserved states (Group 3).
- Similar to the prior SRA, there is a limit to the amount an AIP can place in the Assigned Risk Fund.

The current parameters of the SRA for the applicable crop year should always be reviewed when performing an analysis.

2.5 Accounting Issues

Historically, the accounting for MPCI has been treated differently than most property and casualty lines of business. When the NAIC moved towards consistent reporting requirements during codification, they attempted to make MPCI act more like a typical property line of business. As discussed previously, there is an escrow between the AIP and FCIC where premium and losses are placed. While accounting issues are fluid, MPCI is now treated more like typical property and casualty business in reporting to NAIC. There are several considerations that are unique to MPCI:

- The premium is typically earned from sales closing date to the end of the insurance period (or December 31). This allows for little unearned premium reserves at year-end. The unearned premium at year-end is associated with winter wheat and other crops[12] that extend past the end of the year. The winter wheat coverage is placed in the forthcoming SRA year, so the losses associated with this are not in the current year's SRA.
- The NAIC instructions ask that a company describe its method to earn premium throughout the year on the Notes to the Financial Statement. This is asked since the exposure to loss is not uniform throughout the policy period. A review of major companies' Notes indicate that most companies use a uniform earning pattern due to the difficulty in assessing the exposures over the course of a year.

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12 Usually associated with citrus fruit, trees, nursery, etc.

- The NAIC Statement of Statutory Accounting Principles (SSAP) discusses how to book the amounts associated with MPCI. If the company is at an underwriting gain position, the appropriate amount should be recognized as a write-in asset for a receivable from FCIC. On the other hand, if the company is at a loss position, the company should recognize a write-in liability.
- The SSAP states that the A&O subsidy associated with catastrophic coverage should be recorded as a reduction on loss expenses, whereas the A&O subsidy for other coverages should be recorded as a reduction of underwriting expenses.[13]

The SSAP provides an example of how to calculate the ceded premium and losses after application of the SRA, which is shown below.[14]

[13] The author is unclear as to the basis for the difference in recording A&O subsidy, since the subsidy should be used to pay commissions, general expenses and loss adjusting expenses for all types of policies.

[14] For the 2010 SRA, there is an overall 5% quota-share of net underwriting gain (or loss) in addition to the amounts in the table.

FCIC Fund	(1) Retention %	(2) Gross Written Premium	(3) = (1) x (2) Net Retained Premium	(4) Gross Ultimate Losses	(5) = (1) x (4) Net Retained Losses	(6) = (5) / (3) Retained Loss Ratio
Assigned Risk	20%	$20,000	$4,000	$40,000	$8,000	200.0%
Dev-Other	35%	10,000	3,500	16,000	5,600	160.0
Dev-Revenue	35%	5,000	1,750	7,000	2,450	140.0
Dev-CAT	35%	5,000	1,750	4,000	1,400	80.0
Com-Other	100%	100,000	100,000	80,000	80,000	80.0
Com-Revenue	100%	20,000	20,000	18,000	18,000	90.0
Com-CAT	100%	40,000	40,000	22,000	22,000	55.0
Total		**$200,000**	**$171,000**	**$187,000**	**$137,450**	**80.4%**

FCIC Fund	(7) SRA Provisions Underwriting Gain/(Loss)	(8) = (3) - (5) - (7) Stop-Loss Ceded Premium	(9) = (3) - (5) - (7) Stop-Loss Ceded Loss	(10) = (3) - (8) Retained Premium	(11) = (5) - (9) Retained Loss	(12) = (11) / (10) Retained Loss Ratio
Assigned Risk	$(184)	---	$3,816	$4,000	$4,184	104.6%
Dev-Other	(525)	---	1,575	3,500	4,025	115.0
Dev-Revenue	(210)	---	490	1,750	1,960	112.0
Dev-CAT	158	193	---	1,558	1,400	89.9
Com-Other	18,000	1,200	---	98,000	80,000	81.0
Com-Revenue	1,880	120	---	19,800	18,000	90.5
Com-CAT	12,500	5,500	---	34,500	22,000	63.8
Total	**$32,419**	**$7,013**	**$5,881**	**$163,988**	**$131,569**	**80.2%**

These unique characteristics regarding statutory accounting should be noted when providing unpaid claim liability estimates – especially to make sure the entire earned premium is accounted for in the unpaid claim liability estimates.

3. FORECASTING ULTIMATE LOSSES

Forecasting loss ratios for crop insurance are dependent on the available information at the time of the forecast. During the year, more information is available about the success of the current year's crops, as well as the associated prices. Using this information in conjunction with prior year's loss ratios can assist in forecasting loss ratios during the year. Once harvest is completed and claims have been filed, more traditional actuarial methods can be used.

Due to the characteristics of the SRA, one should estimate the loss ratios on a reinsurance year basis so the effect of the SRA can be used to calculate ceded losses. The loss ratios should be projected on a state/fund basis, as well. The following describes various methods to establish estimated ultimate loss ratios for MPCI.

The loss ratio that is being estimated should be consistent with the definition of premium and indemnity provided by the SRA. The target loss ratio currently mandated by RMA is 100%, since expenses are covered by the A&O subsidy. Therefore, the overall rates are set to the expected long-term losses. Defense and Cost and Containment Expenses (DCCE) are minimal or zero for crop insurance. Adjusting and Other Expenses (AOE) is the cost to handle crop insurance claims and is discussed later.

3.1 MPCI Portfolio Review

The first step in the process should be determining the exposures (liabilities and premiums) by state, crop, insurance plan, and SRA fund. The following table and Exhibit 1 display an example portfolio of MPCI premium:

State	Crop	Insurance Plan	Assigned Risk	Commercial Fund	Developmental Fund
IA	Corn	CRC	50	200	0
IL	Corn	GRIP	50	50	50
IA	Corn	APH	20	100	0
IA	Hybrid Corn Seed	APH	10	0	0
TX	Cotton SE	APH	150	50	0
TX	Cotton AO	APH	50	150	0
TX	Peanuts	APH	25	0	25

This MPCI portfolio will be used in the remainder of this paper to determine the overall gross and net loss ratios for a reinsurance year. In practice, a MPCI portfolio will include many more states and crops. Ultimate loss ratios will be estimated for each significant state/crop/insurance plan so that it can be fed through the SRA terms and a net underwriting gain (or loss) can be calculated.

3.2.1 Using Forecasted Yields to Estimate APH Loss Ratios

Because losses will be based on lower than expected yields, an estimate of the ultimate loss ratio can be made by comparing the forecasted yields for the current year to the actual loss ratios and yields of previous years. Forecasted yields for major crops are made available during the year by several institutions. This paper will discuss the yield forecasting performed by NASS, but other forecasted yields could be used as well.

NASS provides crop production estimates for two components: acres to be harvested and yield per acre. Corn and soybean farmers are surveyed in June regarding the planted acres, and crop production estimates are made each month from August through November. NASS uses two survey methods to estimate yields.[15] Agricultural Yield Survey and Objective Yield Survey. Estimates are made for all major crops in major states. Several of the major producing states are further split into about 10 districts each.

An example of this method will be shown using corn data for the State of Iowa. In practice, Iowa may be split into the NASS districts, since different regions may experience better/worse weather during the year. The first step is to obtain the historical Iowa yields from NASS and the historical loss ratios from RMA. A company with credible data may wish to use their own experience, rather than industry data from RMA. Exhibit 2 displays these values for the APH plan.

The first step is to define a relationship of yield and loss ratio using the historical values. The relationship may not be linear, since lower yields will tend to exceed the deductible and increase the losses at a faster rate. Therefore, quadratic or exponential formulas may be used, a formula that fit well was:

Expected loss ratio = a*1/(y^b) + If (y<1, c(1-y), 0)

Where:

a,b,c = regression coefficients – solved by minimizing the squared error

y = yield ratio = current yield / (previous 10-year yield average)

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15 The detail of NASS methodology can be found in "The Yield Forecasting Program of NASS" issued by the Statistical Methods Branch of NASS.

It should be noted that a 10-year historical average is used as the "expected" yield in the current year. Due to improvements in agricultural practices, as well as the development of crops that are more resistant to adverse weather (particularly drought), crop yields have been increasing. Due to these increasing yield trends, the expected yield in the current year is typically higher than the ten-year average. We can adjust historical yields to "on-level" yields by dividing the current year's yield ratio by the historical yield trend. These results are displayed on Exhibit 3. As shown (by the squared error), the adjustment provides a better fit of the data for this example.

An additional factor was added when yields are significantly low (and loss ratios high) to increase the loss ratios. This is due to both the fact that more policies have claims when yields are lower and the distribution of yields are more diverse in a poor yield year than in a good year. For example, assume that the distribution around the average yield for all corn crops in a county is normally distributed[16] with a mean of one and standard deviation of 0.50. The loss cost for a 65% coverage level APH policy would be 0.0968 per dollar of liability.[17]

The loss cost is calculated using data from many years which have both high yields and low yields. There may also be a difference in the distribution around the mean in a given year; so when yields are high, the distribution around the mean in a given year is low, and when the yields are low, the distribution around the mean in that year is higher. Using the example above, we can compare different scenarios of yields and the deviation around the mean for a 65% coverage level:

Scenario	**Average Yield**	**Variation Around Average**	**Loss Cost Using Scenario Mean and Variation**	**Loss Ratio = Loss Cost / 0.0968**
A	105%	50%	0.0808	83.4%
B	105%	30%	0.0147	15.2%
C	80%	50%	0.1817	187.6%
D	80%	80%	0.2270	286.0%

A review of loss ratios and yield departures indicate that Scenarios B and D are more prevalent than A and C, and this indicates that the yields are more dispersed when yields are low than when they are high.

In the yield and loss ratio regression, a weight is also used in calculating the squared error, which is minimized. This may be used on outlier years or if major changes have been made to the program over the historical experience.

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16 Several studies have been performed to test which statistical distribution best resembles yields. Most conclude that a single distribution does not work well for all crops or for some crops in general. Therefore, most analyses use an empirical fitted formula to calculate rates and coverage level relativities.

17 For ease of example, the yield was set to zero where it is negative.

Using the model described above, we project a 2009 loss ratio of 18%.

A similar approach is used on Exhibit 4 and 5 for Texas cotton. Texas is split into two territories, since there are two distinct growing areas for cotton in Texas: the southeastern coastal bend and the panhandle (or All Other). The model produces loss ratios of:

Southeast	889%
All Other	71%

It should be noted that in years of abnormally low yields, the resulting loss ratio should be compared to the overall liability so that losses do not exceed the liability.

3.2.2 Using Forecasted Yields and Prices to Estimate Revenue Plan Loss Ratios

Revenue plans add an additional parameter in the indemnity calculation; namely, the difference between the spring price and the Harvest Price. There may be several different formulas that can estimate the loss ratio using both the yield and the price component. One method can be to estimate the APH loss ratio and then add a parameter for the revenue risk. However, the popularity of APH plans for corn and soybeans has decreased substantially with the introduction of revenue plans, which reduces the credibility of APH plans loss ratios in recent years. Therefore, in this paper, we show a formula with the combination of yield and price changes.

We can use the same yield departures as in the APH and add the percentage change from the spring price to the fall price, as shown in the following table:

Expected loss ratio = $a*1/((y*p)^b) + \text{If}\ (y<1, c*(1-y), 0)$

Where:
a,b,c = regression coefficients – solved by minimizing the squared error
y = yield ratio = current yield / (previous ten-year yield average)
p = price change = (fall price - spring price) / spring price

For most crops, the fall price is the average daily settlement value during October. Prior to October, these prices can be estimated using the current futures price or other methods.

An example of a loss ratio estimate for revenue coverage for Iowa corn is shown on Exhibit 6. The price changes are displayed on Exhibit 7. The method results in projected loss ratios of 17% for CRC and 13% for RA/IP.

The major difference in the revenue plans is that the price change affects all policies equally, while, as discussed before, the yield distributions vary by whether it was a high- or low-yield year. A low-price and low-yield year would have a multiplicative effect on the losses, and the opposite is also true. The model may need to reflect the harvest price revenue option where the guarantee is the higher of the spring and fall price.

In summary, the loss ratios can be estimated during the year as the forecasted yields and prices become available. Once the harvest is completed and claims are reported, more traditional methods may be added as well.

3.3 Paid to Case Ratios

At the end of the year, when most crops have been harvested and claims have been reported, a more traditional actuarial method may be used. Using the relationship of prior years' ultimate paid losses compared to the case reserves can be used as an indication. Crops or states can be grouped or separated to gain homogeneous groups of claims.

Attention should be paid to the causes of loss from the current year compared to the prior years. For example, are the remaining open claims at a similar point in closing as they were at the same point in time in prior years? If fall weather was poor and harvest was delayed, there may be a delay in the payout process. Agents may report claims differently; some may report a claim for all policyholders in the case of poor weather or prices. Discussions with claims personnel are also important to understand how case reserves are originally set and how they are handled. Claims management may also know certain intricacies about states or crops that are not obvious by looking at the bulk case reserves.

3.4 Estimating GRIP and GRP Liabilities

GRIP and GRP policies are unique in that they do not use the farmer's actual yield, but rather, a county yield index as the basis for payment. GRIP also includes price changes. Losses will occur when county revenue per acre is less than the trigger revenue. Because county revenue is based on both the county average yield and the harvest price, the year-end loss ratio estimate will require estimates of the county average yield. The harvest price should be known at the end of October or November for most crops with GRIP.

The difficulty in estimating loss ratios for GRIP policies at year-end results from the difficulty in estimating the county yield. Publicly available data from NASS estimates yields by state and by districts for the major agricultural states. These crop-production reports are released for each crop year beginning in August for corn and soybeans.

Because yields do not increase or decrease by uniform amounts by county within a district, an additional review is necessary to determine the difference between expected county yields and actual yields within a district for each available year. The table below presents the data for the 2005 year in Illinois District 10:

District 10 County	Acres	GRIP Expected Yield (bushels per acre)	GRIP Final Yield (bushels Per acre)	Final Yield Deviation (%)	GRIP Expected Revenue ($)	GRIP Final Revenue ($)	Final Revenue Deviation (%)
Bureau	288,000	158.6	134.9	(14.9)	377	260	(31.0)
Carroll	139,000	161.9	160.1	(1.1)	385	309	(19.8)
Henry	236,000	152.8	125.0	(18.2)	364	241	(33.7)
Jo Daviess	85,000	142.8	152.0	6.4	340	293	(13.7)
Lee	259,000	158.4	140.7	(11.2)	357	272	(28.0)
Mercer	138,000	150.1	153.9	2.5	369	297	(16.9)
Ogle	221,000	155.2	135.7	(12.6)	385	262	(29.1)
Putnam	42,000	161.8	136.0	(15.9)	373	262	(31.8)
Rock Island	74,000	156.7	138.9	(11.4)	346	268	(28.1)
Stephenson	158,000	145.4	139.4	(4.1)	360	269	(22.3)
Whiteside	229,000	151.3	124.5	(17.7)	322	240	(33.3)
Winnebago	94,000	135.2	125.7	(7.0)	365	243	(24.6)
Total	**1,963,000**	**153.4**	**137.3**	**(10.5)**	**365**	**265**	**(27.4)**

The estimated Illinois farm yield for District 10 was 140 bushels per acre, which was released in November 14, 2005, in the Illinois Farm Report. It should be noted that the published estimated yield is based on harvested acres, whereas the final NASS yield used in calculating the county revenue uses planted acres. NASS does publish forecasted planted and harvest acres so an adjustment can be made.[18] According to the 2005 Farm Report, there were 1,931,000 acres planted and 1,903,000 acres harvested for grain in Illinois District 10; therefore, the yield per planted acre (comparable with the GRP/GRIP yields) would be 137.3. Larger variations between the planted and harvested yields will occur when yields are low, due to total losses caused by floods or droughts. The spring price declined from $2.38 (expected) to $1.93 (final - harvest), or by 18.9%. Therefore, the combination of yield and price decline led to significant indemnities in 2005.

The loss ratios for GRIP policies would be underestimated if one only considered the difference in district or statewide yields, because the variability in county yields is greater due to a smaller sample and local weather events. In the example above, on a district-wide basis, a 70% coverage-level policy would not incur an indemnity since the loss is 27.4%. Due to variability within county yields, however, indemnities would incur at a 70% coverage level for four of the counties in the district.

The following are two methods for calculating potential losses at year-end. The first is to calculate the difference between the expected district yield and the predicted district yield. This amount can be used as the difference in the county yields and includes a provision for variability by

18 There are also several counties which the farmer can choose planted or harvested yields. These counties have a lot of corn which is harvested for silage.

county—for example, reduce all yields by 5% and estimate the losses. If more information is available by county from field adjustors or from the other insurance plans, these could also be used.

The following example shows this methodology for Illinois District 10 during 2007. The price fell from $4.06 per bushel to $3.58, or 11.8%, but the yields were much higher than expected. The Illinois Farm Report, released November 13, 2007, estimated a planted yield of 182 bushels per acre for the district. The table below shows the calculation without any variation in the county yield compared to the district's difference.

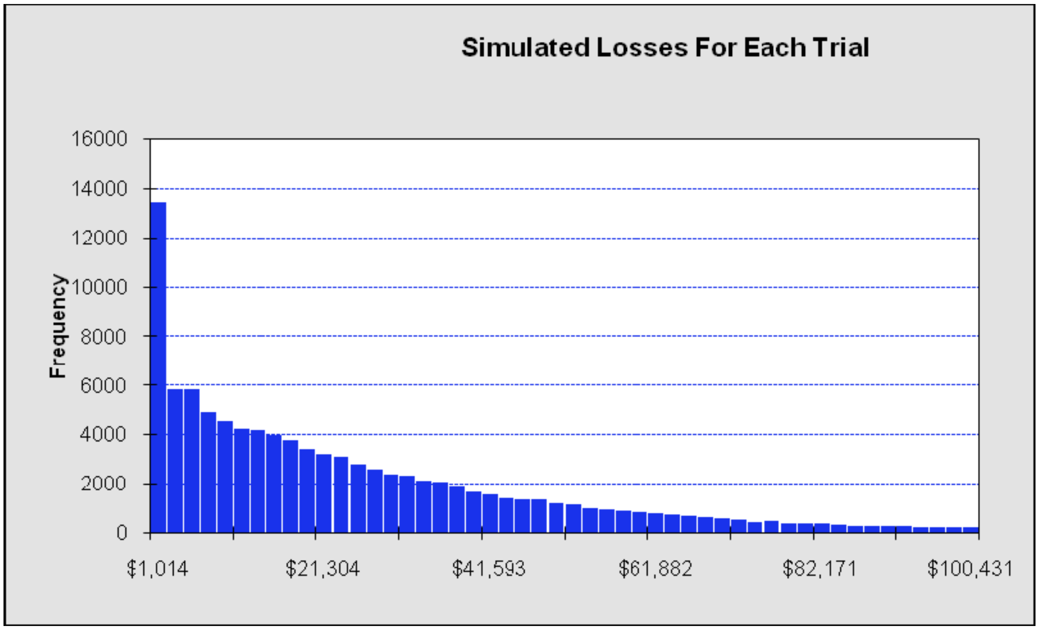
District 10 County	Planted Acres	(A) GRIP Expected Yield (bushels per acre)	(B) GRIP Forecasted Yield (bushels per acre)	(C) = (B)/(A)-1 Final Yield Deviation (%)	(D) = (A)*$4.06 GRIP Expected Revenue ($)	(E) = (B)*$3.58 GRIP Final Revenue ($)	(F)= (E)/(D)-1 Final Revenue Deviation (%)
Bureau	311,000	166	191	14.8%	$674	$682	1.2%
Carroll	155,000	170	195	14.8	689	698	1.2
Henry	257,000	161	185	14.8	654	662	1.2
Jo Daviess	98,000	148	170	14.8	603	610	1.2
Lee	282,000	162	185	14.8	656	664	1.2
Mercer	156,000	164	188	14.8	667	675	1.2
Ogle	244,000	154	177	14.8	626	634	1.2
Putnam	46,000	166	191	14.8	674	683	1.2
Rock Island	79,000	166	191	14.8	674	683	1.2
Stephenson	180,000	152	174	14.8	616	624	1.2
Whiteside	253,000	151	173	14.8	611	619	1.2
Winnebago	102,000	141	162	14.8	572	579	1.2
Total	**2,163,000**	**159**	**182**	**14.8%**	**$644**	**$652**	**1.2%**

The table above assumed that the deviation from expected yields was uniform for each county. The table below shows what estimated final revenues would be for each county based on the yield deviation each county experienced for the 2005 year and applied to 2007:

District 10 County	Planted Acres	(A) GRIP Expected Yield (bushels per acre)	(B) GRIP Forecasted Yield (bushels per acre)	(C) = (B)/(A)-1 Final Yield Deviation (%)	(D) = (A)*$4.06 GRIP Expected Revenue ($)	(E) = (B)*$3.58 GRIP Final Revenue ($)	(F)= (E)/(D)-1 Final Revenue Deviation (%)
Bureau	311,000	166	181	9.1%	$674	$648	(3.8)%
Carroll	155,000	170	215	26.8	689	771	11.8
Henry	257,000	161	169	4.9	654	605	(7.5)
Jo Daviess	98,000	148	203	36.5	603	725	20.4
Lee	282,000	162	184	13.9	656	659	0.5
Mercer	156,000	164	216	31.5	667	773	15.9
Ogle	244,000	154	173	12.1	626	619	(1.1)
Putnam	46,000	166	179	7.8	674	641	(4.9)
Rock Island	79,000	166	189	13.7	674	676	0.2
Stephenson	180,000	152	187	23.0	616	668	8.4
Whiteside	253,000	151	159	5.5	611	569	(6.9)
Winnebago	102,000	141	168	19.2	572	602	5.1
Total	**2,163,000**	**159**	**182**	**14.8%**	**$644**	**$652**	**1.2%**

The second method is to set up a Monte Carlo simulation for actual county yields based on the difference between the expected district yields and the predicted district yields.

A simulation model could vary the GRIP forecasted yields by county based on the historical difference between the yields by county. The following graph shows the results of 100,000 trials for the district based on the 2007 estimated yields for a hypothetical portfolio of GRIP policies. A normal distribution with a standard deviation of 12.5% was used to model the difference from the forecasted yield as a district as a whole compared to each individual county yield.



While the graph above displays the results for only Illinois District 10, the simulation could capture losses for each state or crop with significant GRIP (and GRP) liabilities. The results of this model could then be fed into the overall SRA model to estimate the net underwriting gain (or loss) for the reinsurance year.

3.5 Minor State, Crops, and Plans

Because of credibility considerations, the methods described above are only suitable for the largest states and crops in the MPCI portfolio. The remaining liabilities need to be accounted for in estimating the overall loss ratios by state and SRA fund. There are several methods to estimate the losses for minor states and crops. These crops are typically minor field crops, fruits and vegetables for which NASS does not provide a forecasted yield.

As a first step, we can calculate the historical loss ratios for these crops and a comparative crop using the RMA data. Using the comparative crop's loss ratio for the current year, we can adjust the historical loss ratio to the current year. This is shown in the table below:

(1) State /Crop / Plan	(2) Historical Loss Ratio	(3) Comparative Historical Loss Ratio[1]	(4) 2009 Comparative Loss Ratio[2]	(5) 2009 Estimated Loss Ratio[3]
IA, Hybrid Corn Seed, APH	51%	54%	18%	17%
TX, Peanuts	50%	93%	71%	38%

[1] Iowa Corn APH and Texas Cotton All Other Counties APH

[2] From previous analysis.

[3] = (2)/(3) x (4)

For hurricane-prone areas, we may adjust the historical loss ratios, based on the time of the year and whether a hurricane occurred or not, using a Bornhuetter-Ferguson approach. At year-end, it may be possible to use a paid to case method to estimate these losses.

3.6 Timeline of Indications

The process for estimating ultimate loss ratios for crop insurance is similar to other property lines of business where one starts with an expected loss ratio and changes the expectation due to events during the year.

The following table displays a possible timeline for various crops and the different actuarial methods that may be used. The timelines are shown for a given reinsurance year (consistent with the SRA).

	Oct - April	May - July	Aug - Nov	Dec - March	April - June
Winter Wheat	Expected Loss Ratio	Paid-to-Case	Paid-to-Case	Paid-to-Case	Paid-to-Case
Traditional Row Crops	N/A	Expected Loss Ratio	Forecasted Loss Ratio	Forecasted LR Paid-to-Case Expected Paid Method	Paid-to-Case
Citrus	N/A	Expected Loss Ratio	Expected Paid Method	Expected Paid Method	Paid-to-Case
GRP/GRIP	N/A	Expected Loss Ratio	Forecasted Loss Ratio	Forecasted Loss Ratio	Actual Results

3.7 Summarizing data into the SRA

After the ultimate loss ratios are estimated, they can be summarized into state/fund to apply the reinsurance of the SRA. As shown on Exhibit 8, the overall gross loss ratio is 207%. This gross loss ratio needs to be applied to the SRA to produce a net underwriting gain. In this example, the gross loss ratio of 207% equates to a 9.2% gain after the SRA parameters are applied. This is because most of the losses occurred in one state (Texas) and the majority of these policies were placed in the assigned risk fund.

3.8 Crop-Hail

The major difference in most crop-hail plans compared to MPCI is the occurrence of a claim is on a certain date and payment is made shortly afterwards. Therefore, more traditional actuarial methods may be appropriate. At the end of the year, most crop-hail claims should be reported and many of these are settled. Therefore, more traditional actuarial methods may be appropriate. During the year, an expected paid (or reported) method may be used with an expected loss ratio and a payment (or reported) pattern. States could be grouped where the hail exposure is similar. For example, more hail storms occur earlier in the year the further south the area is.

3.9 Reserve Ranges

There are many ways to measure reasonable reserve ranges in property and casualty insurance. A key issue with MPCI is the SRA, which limits the net underwriting gain or loss by state and SRA fund. For example, a state with a very high or low loss ratio may not significantly change the overall underwriting gain or loss by using an even higher or lower loss ratio.

A few examples to produce reserve ranges are discussed here. The regression methods using forecasted yields would produce a standard error for each regression which can be used in selecting the ranges. The loss ratios for nearby states are most likely not independent and this should be considered in the range. The GRIP/GRP simulation can create distributions, but the overall range would need to account for the dependency between these policies and other policies. It would also depend on the time of year the range is calculated.

3.10 Issues with Traditional Actuarial Methods

There are several reasons why traditional actuarial methods may not be appropriate for crop insurance. The structure of the SRA, which limits underwriting gain or loss by state and fund, requires the projection of losses by state/fund. As shown previously, net losses can be significantly different than gross losses due to the distribution of losses (and placement of policies) between funds. Unique characteristics of some policies such as GRIP make loss development type methods inappropriate. The payout of claims throughout the year is not consistent between years. For example, a flood in the spring may bring many early payments, but the harvest may turn out well and have few losses. The change in price, which is a significant function of many policies, is not known until the end of October for most crops. The harvesting of crops may be delayed in the fall, which may delay the reporting of claims and the settlement of these claims.

These and other reasons should be accounted for when making actuarial projections. The time of the year when the evaluation is taking place should be a key consideration in the appropriate actuarial methods to use.

3.11 Adjusting and Other Expenses

Adjusting and Other Expense (AOE) liabilities may also need to be estimated for crop insurance. Both MPCI and crop-hail are similar to property insurance, where the more claims there are, the more adjusting costs will be. Therefore, traditional actuarial methods may be used to estimate AOE liabilities. Since some of the policies are based on indices (GRIP, RI, VI, livestock, etc.) where considerable less claim handling involved, an adjustment to an overall paid-to-paid type approach may be warranted for these policies.

3.12 Areas for Further Research

While this paper presents several methodologies to estimate ultimate loss ratios, there are other methods that could be used. A "ground-up" method where the indemnity of all policies would be calculated with an expected yield compared to approved yields. These yields could vary based on yield distributions. In other words, instead of all yields being 10% below approved yields, one could make a distribution of yield deviations from the approved yield. As discussed previously, when yields are low, the distribution tends to be greater. Prices would also have to be estimated as well.

4. CONCLUSIONS

Crop insurance is unique to the property/casualty insurance industry. The short-tailed catastrophic exposure and the terms of the SRA need to be recognized when estimating ultimate loss ratios and unpaid claim liabilities. This paper outlines several methods of estimating the ultimate loss ratios for different policy types. New and unique insurance products are being introduced and will be introduced over time. Changes in farming practices will impact future yields and which crops are grown. The process for estimating ultimate loss ratios should be adaptable to the current policies and conditions.

Acknowledgment

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5. REFERENCES

Appel, D., and P. Borba, *"Historical Rate of Return Analysis"*, 2009, United States Department of Agriculture, Risk Management Agency.

National Association of Insurance Commissioners, *Accounting Practices and Procedures Manual,* As of March 2008.

The Statistical Methods Branch, United States Department of Agriculture, National Agricultural Statistics Service, "The Yield Forecasting Program of NASS," SMB Staff Report Number SMB06-01, May 2006.

United States Department of Agriculture, Risk Management Agency; http://www.rma.usda.gov/

Abbreviations and Notations

A&O Subsidy - Administrative and Operational Expenses
AGR - Adjusted Gross Revenue
AIP - Approved Insurance Provider
AOE - Adjusting and Other Expenses
APH - Actual Production History
CAT - Catastrophic Coverage
CBOT - Chicago Board of Trade
CRC - Crop Revenue Coverage
DCCE - Defense and Cost Containment Expenses
FCIC - Federal Crop Insurance Corporation
GRIP - Group Risk Income Plan
GRP - Group Risk Plan
IP - Income Protection
LGM - Livestock Gross Margin
LRP - Livestock Risk Protection
MPCI - Multi-peril Crop Insurance
NAIC - National Association of Insurance Commissioners
NASS - United States Department of Agriculture - National Agricultural Statistics Service
NDVI - Normalized Difference Vegetation Index
NOAA-CPC - National Oceanic and Atmospheric Administration - Climate Prediction Center
RA - Revenue Assurance
RI - Rainfall Index
RMA - Risk Management Agency of the United States Department of Agriculture
SRA - Standard Reinsurance Agreement
USDA - United States Department of Agriculture
VI - Vegetation Index

Biography of the Author

Carl Xavier Ashenbrenner is a Principal and Consulting Actuary at Milliman, Inc. in Brookfield, Wisconsin. He specializes in reserving and ratemaking for property/casualty insurance with an emphasis on non-traditional lines of business. He holds a bachelor of Business Administration in Actuarial Science and Risk Management and Insurance from the University of Wisconsin–Madison. He is a Fellow of the CAS and a Member of the American Academy of Actuaries. He is a volunteer of the CAS Program Planning Committee, and is a frequent speaker and moderator at CAS meetings and other industry events.

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Exhibit 1

Hypothetical MPCI Portfolio

			Premium			
State	Crop	Insurance Plan	Assigned Risk	C-Fund	D-Fund	Total
IA	Corn	CRC	50	200	0	250
IL	Corn	GRIP	50	50	50	150
IA	Corn	APH	20	100	0	120
IA	Hybrid Corn Seed	APH	10	0	0	10
TX	Cotton SE	APH	150	50	0	200
TX	Cotton AO	APH	50	150	0	200
TX	Peanuts	APH	25	0	25	50
		Total	**355**	**550**	**75**	**980**

Exhibit 2

Iowa Corn
Crop Year 2009
Loss Ratio Projection
APH Plan

(1) Year	(2) Nass Yield	(3) 10yr Average	(4) Yield Ratio	(5) Low Yield Indicator	(6) Actual Loss Ratio	(7) Fitted Loss Ratio	(8) Squared Error	(9) Weight
1980	105							
1981	120							
1982	115							
1983	82							
1984	108							
1985	123							
1986	132							
1987	127							
1988	80							
1989	115							
1990	122	111	110%	0.00	30%	35%	0.00	1
1991	114	112	102%	0.00	72%	52%	0.04	1
1992	144	112	129%	0.00	17%	16%	0.00	1
1993	73	115	64%	0.36	496%	498%	0.00	1
1994	148	114	130%	0.00	5%	15%	0.01	1
1995	120	118	102%	0.00	98%	52%	0.21	1
1996	135	118	115%	0.00	24%	29%	0.00	1
1997	135	118	114%	0.00	7%	30%	0.05	1
1998	142	119	119%	0.00	41%	24%	0.03	1
1999	145	125	116%	0.00	20%	27%	0.00	1
2000	140	128	110%	0.00	11%	36%	0.06	1
2001	142	130	110%	0.00	43%	36%	0.00	1
2002	158	132	120%	0.00	11%	24%	0.02	1
2003	152	134	113%	0.00	15%	31%	0.03	1
2004	177	142	125%	0.00	9%	19%	0.01	1
2005	169	145	117%	0.00	22%	26%	0.00	1
2006	163	149	109%	0.00	20%	37%	0.03	1
2007	167	152	110%	0.00	13%	36%	0.05	1
2008	165	156	106%	0.00	76%	43%	0.11	1
					54%	56%		
		A	B	C	D			
		0.565	4.873	-	1.000		66	<-Minimize
2009	178	158	113%	0.00		31%		

Fitted Loss Ratio = A * [1 / (Yield Ratio^B)] + Low Yield Indicator * C

(2)	NASS: Production / Planted Acres	(6)	From RMA
(3)	Previous 10-year average of (2)	(7)	Fitted Loss Ratio
(4)	= (2) / (3)	(8)	=[(6) - (7)] ^2
(5)	If (4) < 1.00 then [1-(4)]	(9)	Judgment

Exhibit 3

Iowa Corn
Crop Year 2009
Loss Ratio Projection
APH Plan

(1) Year	(2) Nass Yield	(3) 10yr Average	(4) Yield Ratio	(5) Adjusted Yield Ratio	(6) Low Yield Indicator	(7) Actual Loss Ratio	(8) Fitted Loss Ratio	(9) Squared Error	(10) Weight
1980	105								
1981	120								
1982	115								
1983	82								
1984	108								
1985	123								
1986	132								
1987	127								
1988	80								
1989	115								
1990	122	111	110%	99%	0.01	30%	27%	0.00	1
1991	114	112	102%	91%	0.09	72%	87%	0.02	1
1992	144	112	129%	116%	0.00	17%	10%	0.01	1
1993	73	115	64%	57%	0.43	496%	496%	0.00	1
1994	148	114	130%	117%	0.00	5%	9%	0.00	1
1995	120	118	102%	91%	0.09	98%	87%	0.01	1
1996	135	118	115%	103%	0.00	24%	17%	0.00	1
1997	135	118	114%	102%	0.00	7%	17%	0.01	1
1998	142	119	119%	107%	0.00	41%	14%	0.07	1
1999	145	125	116%	104%	0.00	20%	16%	0.00	1
2000	140	128	110%	98%	0.02	11%	30%	0.04	1
2001	142	130	110%	98%	0.02	43%	32%	0.01	1
2002	158	132	120%	107%	0.00	11%	14%	0.00	1
2003	152	134	113%	102%	0.00	15%	17%	0.00	1
2004	177	142	125%	112%	0.00	9%	12%	0.00	1
2005	169	145	117%	105%	0.00	22%	15%	0.00	1
2006	163	149	109%	98%	0.02	20%	37%	0.03	1
2007	167	152	110%	98%	0.02	13%	30%	0.03	1
2008	165	156	106%	95%	0.05	76%	58%	0.03	1
Average Yield Trend:			112%			54%	54%		
			A	B	C	D			
			0.188	4.374	6.605	1.000		28	<-Minimize
2009	178	158	113%	101%	0.00		18%		

Fitted Loss Ratio = A * [1 / (Adjusted Yield Ratio^B)] + Low Yield Indicator * C

(2)	NASS: Production / Planted Acres	(7)	From RMA
(3)	Previous 10-year average of (2)	(8)	Fitted Loss Ratio
(4)	= (2) / (3)	(9)	=[(6) - (7)] ^2
(5)	= (4) / Average Yield Trend	(10)	Judgment
(6)	If (4) < 1.00 then [1-(4)]		

Exhibit 4

Texas Cotton Southeast
Crop Year 2009
Loss Ratio Projection
APH Plan

(1) Year	(2) Nass Yield	(3) 10yr Average	(4) Yield Ratio	(5) Adjusted Yield Ratio	(6) Low Yield Indicator	(7) Actual Loss Ratio	(8) Fitted Loss Ratio	(9) Squared Error	(10) Weight
1980	338								
1981	482								
1982	524								
1983	576								
1984	635								
1985	751								
1986	649								
1987	663								
1988	622								
1989	510								
1990	541	575	94%	94%	0.06	246%	130%	1.34	1
1991	663	595	111%	112%	0.00	104%	94%	0.01	1
1992	506	614	82%	83%	0.17	244%	175%	0.47	1
1993	520	612	85%	85%	0.15	140%	164%	0.06	1
1994	638	606	105%	106%	0.00	58%	102%	0.20	1
1995	433	606	71%	72%	0.28	245%	229%	0.02	1
1996	345	575	60%	60%	0.40	249%	303%	0.30	1
1997	512	544	94%	94%	0.06	95%	130%	0.13	1
1998	385	529	73%	73%	0.27	164%	222%	0.33	1
1999	659	505	130%	131%	0.00	75%	74%	0.00	1
2000	627	520	121%	121%	0.00	73%	83%	0.01	1
2001	503	529	95%	96%	0.04	143%	127%	0.03	1
2002	493	513	96%	97%	0.03	172%	123%	0.24	1
2003	665	512	130%	131%	0.00	53%	74%	0.04	1
2004	750	526	143%	143%	0.00	22%	64%	0.18	1
2005	594	537	111%	111%	0.00	51%	95%	0.19	1
2006	400	553	72%	73%	0.27	291%	224%	0.45	1
2007	798	559	143%	143%	0.00	26%	64%	0.14	1
2008	442	588	75%	76%	0.24	205%	209%	0.00	1
	Average Yield Trend:		100%			140%	141%		
			A	B	C	D			
			1.116	1.539	1.508	1.000		415	<-Minimize
2009	167	593	28%	28%	0.72		889%		

Fitted Loss Ratio = A * [1 / (Adjusted Yield Ratio^B)] + Low Yield Indicator * C

(2) NASS: Production / Planted Acres
(3) Previous 10-year average of (2)
(4) = (2) / (3)
(5) = (4) / Average Yield Trend
(6) If (4) < 1.00 then [1-(4)]
(7) From RMA
(8) Fitted Loss Ratio
(9) =[(6) - (7)] ^2
(10) Judgment

Exhibit 5

Texas Cotton All Other
Crop Year 2009
Loss Ratio Projection
APH Plan

(1) Year	(2) Nass Yield	(3) 10yr Average	(4) Yield Ratio	(5) Adjusted Yield Ratio	(6) Low Yield Indicator	(7) Actual Loss Ratio	(8) Fitted Loss Ratio	(9) Squared Error	(10) Weight
1980	192								
1981	358								
1982	203								
1983	269								
1984	307								
1985	338								
1986	215								
1987	461								
1988	462								
1989	610								
1990	475	341	139%	126%	0.00	89%	62%	0.07	1
1991	332	370	90%	81%	0.19	238%	158%	0.65	1
1992	276	367	75%	68%	0.32	408%	220%	3.55	1
1993	459	374	122%	111%	0.00	77%	69%	0.01	1
1994	418	393	106%	96%	0.04	65%	92%	0.07	1
1995	324	405	80%	73%	0.27	103%	199%	0.92	1
1996	381	403	95%	86%	0.14	145%	138%	0.01	1
1997	452	420	108%	98%	0.02	46%	86%	0.16	1
1998	377	419	90%	82%	0.18	197%	156%	0.17	1
1999	370	410	90%	82%	0.18	120%	156%	0.13	1
2000	249	386	64%	58%	0.42	168%	271%	1.05	1
2001	321	364	88%	80%	0.20	151%	164%	0.02	1
2002	433	363	119%	108%	0.00	78%	71%	0.01	1
2003	327	378	86%	78%	0.22	161%	171%	0.01	1
2004	621	365	170%	154%	0.00	26%	52%	0.07	1
2005	707	385	184%	166%	0.00	34%	49%	0.02	1
2006	451	424	106%	96%	0.04	130%	91%	0.15	1
2007	821	431	191%	173%	0.00	20%	48%	0.08	1
2008	433	468	93%	84%	0.16	133%	146%	0.02	1
Average Yield Trend:			110%			126%	126%		
			A	B	C	D			
			0.755	0.847	3.630	1.000		715	<-Minimize
2009	566	473	120%	108%	0.00		71%		

Fitted Loss Ratio = A * [1 / (Adjusted Yield Ratio^B)] + Low Yield Indicator * C

(2) NASS: Production / Planted Acres
(3) Previous 10-year average of (2)
(4) = (2) / (3)
(5) = (4) / Average Yield Trend
(6) If (4) < 1.00 then [1-(4)]
(7) From RMA
(8) Fitted Loss Ratio
(9) =[(6) - (7)] ^2
(10) Judgment

Exhibit 6

Iowa Corn
Crop Year 2009
Loss Ratio Projection
Revenue Plans

(1) Year	(2) Ins Plan	(3) Nass Yield	(4) 10yr Average	(5) Yield Ratio	(6) Adjusted Yield Ratio	(7) Low Yield Indicator	(8) Price Change	(9) Price Times Yield	(10) Actual Loss Ratio	(11) Fitted Loss Ratio	(12) Squared Error	(13) Wght
2000	CRC	140	128	110%	97%	0.03	-0.16	0.82	41%	45%	0.00	1
2001	CRC	142	130	110%	97%	0.03	-0.17	0.81	70%	48%	0.05	1
2002	CRC	158	132	120%	106%	0.00	0.09	1.15	17%	5%	0.01	1
2003	CRC	152	134	113%	100%	0.00	-0.07	0.94	19%	15%	0.00	1
2004	CRC	177	142	125%	110%	0.00	-0.28	0.80	18%	31%	0.02	1
2005	CRC	169	145	117%	103%	0.00	-0.13	0.90	23%	18%	0.00	1
2006	CRC	163	149	109%	96%	0.04	0.17	1.13	24%	28%	0.00	1
2007	CRC	167	152	110%	97%	0.03	-0.12	0.86	21%	39%	0.03	1
2008	CRC	165	156	106%	93%	0.07	-0.24	0.71	93%	91%	0.00	1
2000	RA/IP	140	128	110%	97%	0.03	-0.16	0.82	32%	45%	0.02	1
2001	RA/IP	142	130	110%	97%	0.03	-0.17	0.81	88%	48%	0.16	1
2002	RA/IP	158	132	120%	106%	0.00	0.05	1.11	24%	7%	0.03	1
2003	RA/IP	152	134	113%	100%	0.00	-0.02	0.98	18%	12%	0.00	1
2004	RA/IP	177	142	125%	110%	0.00	-0.30	0.77	23%	36%	0.02	1
2005	RA/IP	169	145	117%	103%	0.00	-0.17	0.86	34%	22%	0.01	1
2006	RA/IP	163	149	109%	96%	0.04	0.37	1.32	23%	25%	0.00	1
2007	RA/IP	167	152	110%	97%	0.03	-0.06	0.91	15%	33%	0.03	1
2008	RA/IP	165	156	106%	93%	0.07	-0.31	0.65	118%	124%	0.00	1
	Average Yield Trend:			113%					39%	37%		
					A	B	C	D				
					0.106	4.800	5.840	1.000			12	<-Min
2009	CRC	178	158	113%	100%	0.00	-0.08	0.92		16%		
2009	RA/IP	178	158	113%	100%	0.00	-0.03	0.96		13%		

Fitted Loss Ratio = A * [1 / ([Adjusted Yield Ratio*(1-Price Change)]^B)] + Low Yield Indicator * C

(3) NASS: Production / Planted Acres
(4) Previous 10-year average of (2)
(5) = (3) / (4)
(6) = (5) / Average Yield Trend
(7) If (6) < 1.00 then [1-(6)]
(8) From RMA
(9) = (6) X [1 + (8)]
(10) From RMA
(11) Fitted Loss Ratio
(12) =[(10) - (11)] ^2
(13) Judgment

Exhibit 7

Corn
Price Changes
March 15th Sales Closing

Crop	RA and IP			CRC - HRO		
Year	Base	Harvest	Change	Base	Harvest	Change
2000	$ 2.51	$ 2.11	-16%	$ 2.51	$ 2.11	-16%
2001	$ 2.46	$ 2.05	-17%	$ 2.46	$ 2.05	-17%
2002	$ 2.32	$ 2.43	5%	$ 2.32	$ 2.52	9%
2003	$ 2.42	$ 2.37	-2%	$ 2.42	$ 2.26	-7%
2004	$ 2.83	$ 1.99	-30%	$ 2.83	$ 2.05	-28%
2005	$ 2.32	$ 1.93	-17%	$ 2.32	$ 2.02	-13%
2006	$ 2.59	$ 3.56	37%	$ 2.59	$ 3.03	17%
2007	$ 4.06	$ 3.82	-6%	$ 4.06	$ 3.58	-12%
2008	$ 5.40	$ 3.74	-31%	$ 5.40	$ 4.13	-24%
2009	$ 4.04	$ 3.90	-3%	$ 4.04	$ 3.72	-8%

Exhibit 8

Hypothetical MPCI Portfolio

			Premium			
State	Crop	Insurance Plan	Assigned Risk	C-Fund	D-Fund	Total
IA	Corn	CRC	50	200		250
IL	Corn	GRIP	50	50	50	150
IA	Corn	APH	20	100		120
IA	Hybrid Corn Seed	APH	10			10
TX	Cotton SE	APH	150	50		200
TX	Cotton AO	APH	50	150		200
TX	Peanuts	APH	25		25	50
		Total	**355**	**550**	**75**	**980**

			Gross Loss Ratio			
State	Crop	Insurance Plan	Assigned Risk	C-Fund	D-Fund	Total
IA	Corn	CRC	16%	16%	16%	16%
IL	Corn	GRIP	17%	17%	17%	17%
IA	Corn	APH	18%	18%		18%
IA	Hybrid Corn Seed	APH	17%	17%		17%
TX	Cotton SE	APH	889%	889%		889%
TX	Cotton AO	APH	71%	71%		71%
TX	Peanuts	APH	38%		38%	38%
		Total	**394%**	**111%**	**24%**	**207%**

			Gross Losses			
State	Crop	Insurance Plan	Assigned Risk	C-Fund	D-Fund	Total
IA	Corn	CRC	8	32	-	40
IL	Corn	GRIP	9	9	9	26
IA	Corn	APH	4	18	-	21
IA	Hybrid Corn Seed	APH	2	-	-	2
TX	Cotton SE	APH	1,333	444	-	1,777
TX	Cotton AO	APH	35	106	-	141
TX	Peanuts	APH	9	-	9	19
		Total	**1,399**	**608**	**18**	**2,026**