Climate Effects on Rainfall Index Insurance Purchase Decisions

By James L. Novak and Denis Nadolynyak

Abstract

Rainfall Index (RI) insurance provides forage and hay producers with group risk protection against drought related losses. However, insurance premiums and risk protection are currently based on pooled weather data series and do not account for the impacts of specific climate phases, specifically the El Niño Southern Oscillation (ENSO), on local rainfall distribution. This analysis examines differences in the expected payoffs on the RI insurance under varying coverage levels based on probabilities of rainfall shortage during specific climate events at four Agricultural Experiment Stations in Alabama. Policy makers and producers are expected to benefit from the results that show the varying effects of climate on expected payouts from this insurance.

Introduction

Over the past decades, alternative crop yield and revenue insurance have been tried in an attempt to increase participation rates and to lower the loss ratios. Some programs were aimed at reducing the moral hazard and adverse selection issues inherent in individual insurance contracts and some tried to make contracts more efficient (cover larger portions of risks born by the producer) by utilizing innovative products. The two objectives are often in conflict as exemplified by the tradeoff between the area-yield (Group Risk Product or GRP) and farm-level (APH) yield insurance. Up until recently, none of these pilot designs were very successful (Glauber, 2004).

One of the promising venues in the agricultural insurance design is index insurance which largely avoids the moral hazard issues and is especially applicable for crops and areas with limited/unreliable yield/revenue records. While the GRP has been relatively successful, rainfall index insurance has been showing promise where agriculture is more rainfall dependent and reliable yield records are lacking (Skees, 2008). In the United States, Rainfall Index (RI) insurance and Vegetation Index insurance (VI) were offered as pilot programs starting 2007.

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The authors gratefully acknowledge the financial support provided by the Southeast Climate Consortium and CSREES/USDA for conducting this research.

RI is a pilot group risk insurance product offered to protect the producers of hay and pasture in all or part of the 13 states currently eligible against the occurrence of drought. States currently included in this pilot program are all of Alabama, Montana, Colorado, Missouri, and North Carolina and most counties in Virginia and South Carolina. Select counties included in other states are North Dakota, Colorado, Oklahoma, Texas, Pennsylvania, and New York. The Risk Management Agency USDA states that this insurance is "primarily intended for use by producers whose crop production tends to follow the average precipitation or vegetation patterns for a 12x12 mile precipitation grid according to historic rainfall patterns." Filling an important niche, this product provides group risk insurance for hay and forage producers. As a single hazard group risk insurance, indemnity payments are based solely on rainfall shortages from averages during bimonthly time periods in a Grid. The insurance does not protect individual production shortages. All producers indemnified receive payment for losses in the Grid and not for individual farm losses. As a group risk product, no individual production verification is required. For the insurance, the production year runs from February to January and indemnifies the bi-monthly production periods February-March, April-May, June-July, August-September, October-November, and December-January.

The RI premiums and potential indemnity payments are based on average climatic conditions going back to 1948. However, climate research indicates that, in some areas of the U.S. and particularly in the Southeast, cumulative rainfall distributions differ by what's called the El Niño Southern Oscillation (ENSO) climate phase (El Niño, La Niña, and Neutral). Consequently, the optimal level of insurance protection for hay and forage production may depend significantly on the ENSO phase.

This analysis examines the maximum expected payoff from the RI insurance from hay production for two-month indemnity periods based on cumulative probabilities of rainfall shortage during alternative ENSO climate phases at four Alabama Agricultural Experiment Stations. The objective of the study is to determine whether ENSO phases alter producer decisions with regard to when and how much RI protection to purchase. The results showing that expected indemnity payoffs from insuring bi-monthly periods vary by ENSO phase may be useful to policy makers and producers decisions.

Crop Production and ENSO Phase

The concept of rainfall and weather related index insurance has been presented in Miranda, (1991), Skees, et al. (2001); and Martin, et al. (2001) studies. Although presented as a workable concept in these papers, RI insurance was only introduced in the U.S. relatively recently. In Alabama, the insurance first became available in 2007.

Alabama, Texas, South Carolina, North Carolina, and Virginia are states currently cited as being strongly affected by the El Niño Southern Oscillation. The implications of this study for purchasing RI insurance according to ENSO phase are especially relevant to these states and for those cited in the Mjelde, Hill, and Griffiths (1998) study as they are added to the RI program.

The relationship between ENSO climate phases and agricultural production in the southeastern U.S. has been well documented (Baigorria et al., 2008; Hansen, Hodges, and Jones, 1998). Mjelde, et al. cite a correlation between U.S. weather parameters and ENSO along the Gulf Coast and in the Northeastern, Southwestern, and Northwestern regions of the country. Gershunov (1998) examined intra-seasonal impacts of ENSO on rainfall. Carriquiry and Osgood (2008) examined the interaction of climate forecasts and index insurance as a way to manage climates risk in agriculture in developing countries. Podesta, et al. (2002) highlighted the implications of the ENSO phases for agricultural decision making in Argentina. Khalil, et al. (2007) examined ESNO phase impacts on rainfall and proposed rainfall index insurance as protection against crop losses due to floods in Peru. Nadolnyak, et al. (2008) found differences in yield distributions of cotton, corn and peanuts under different ENSO phases in the southeastern U.S. and cited implications for actuarial improvements in group risk insurance products through use of ENSO phase data.

Rainfall Index Insurance

RI insurance in the U.S. is a group risk insurance program that protects hay and forage production in a 12 x 12 mile "Grid" against shortages of rainfall during two-month "intervals" during a production year. For RI, the production year is divided into six intervals for each Grid which starts with February-March and ends with December-January. Producers are required to indemnify at least two Intervals and distribute a minimum of 10 percent and a maximum of 50 percent of their crop acreage (forage, pasture, or hay) in the indemnified periods. More than two intervals may be indemnified but not more than 100% of acreage can be insured in the Intervals. For simplification purposes and comparisons between ENSO events only two Intervals per location will be highlighted in this study.

Normal rainfall for two-month intervals within each of the four study site 12 x 12 Grids were determined based on the National Oceanic and Atmospheric Administration (NOAA) data. Average rainfall values for forage and hay production in each Grid have been converted to dollar denominated "County Base Values" (CBV) by the Risk Management Agency (RMA) based on historic production for that Grid. Insurance "Coverage Levels" (CL) available to producers for hay or forage protection range from 70 to 90 percent. Producers may adjust RI coverage within a Grid for their own acreage productivity above or below average by multiplying dollar protection levels by productivity factors ranging from 60 to 150 percent.

At the end of each two-month Interval, NOAA calculates a Final Grid Index value (FGI) of rainfall for each Grid. Payments are triggered when the FGI value falls below the selected coverage level chosen for an indemnified two month period.

Forage and hay production have different CBV's which affects the value but not the incidence of the indemnity. In this analysis we focus on hay production only. Hay Grids insured under RI are modeled using data from four Alabama Experiment Stations. These sites represent four distinct production regions: Coastal Plains (Fairhope, Grid 38088); Wiregrass (Headland, Grid 37135); Piedmont (Chilton, Grid 34882); and the Tennessee Valley (Belle Mina, Grid 33914). Hay acreage at the four stations was assumed to be contained within single Grids. Historic rainfall and Grid data used in this analysis are available at the URL http://prfri-rma-map.tamu.edu.

ENSO Phase and Climate

ENSO phase (event) impact on climate occurs through complex atmospheric interactions starting with Pacific Ocean temperature changes (www.agroclimate.org). El Niño is the ENSO phase in which the ocean temperature is cooler than normal and La Niña is the opposite. The deviations from average ocean temperatures change global atmospheric circulation affecting weather and climate patterns in Alabama and other regions of the country. Climatic effects from specific ENSO events depend on the time of the year. In the Gulf Coast region, La Niña results in below normal rainfall in the winter and spring seasons that are critical for moisture recharge and planting. El Niño, on the other hand, results in above normal rainfall in winter and spring and below normal rainfall during July-September.

In the southeastern U.S., ENSO effects are thought to weaken with distance from the coast. Because of the increasing distance from the coast and differences in production region, it is expected that indemnity payments also vary for the four sites in Alabama.

ENSO and Rainfall Index Insurance

The question to be answered by this study is whether expected payoffs from RI insurance for an Interval and Grid differ by ENSO phases. If there is a difference, the question is what Intervals provide highest payoffs under distinct ENSO phases.

The RI insurance actuarial rates are set by the RMA/USDA and are based on average climate data going back to 1948. The ENSO impact is not currently considered in setting the premium rates. It is assumed for this analysis that insurance rates will continue to be based on pooled rainfall averages and not on ENSO-specific distributions. However, ENSO phase forecasts of high accuracy (www.agroclimate.org) often become available well before the contract closing dates. Thus, the objective of our analysis is to find out whether producers could potentially use ENSO phase forecasts to minimize the error of insuring the wrong two Intervals. An implication also exists for policy makers to base future rates on specific ENSO phase if additional information results in net gains.

Method

Dollar Income Protection (DIP) levels net of insurance costs were determined for each of the four locations selected for this study using the Hay Premium costs and BCV's determined by the USDA's Risk Management Agency. Indemnity levels were calculated at 70 percent, 75 percent, 80 percent, 85 percent, and 90 percent Coverage Levels (CL) and for 60 percent, 100 percent, and 150 percent Productivity Factors (PF). CL's are based on 100 percent of average rainfall for a 12x12 mile Grid. PF is a producer's estimate of his or her deviation from normal productivity for the Grid. Calculations show that the 150 percent PF always resulted in the highest dollars of protection. Since we are only examining differences in insured Intervals according to ENSO phase, this paper only presents 150 percent PF to simplify presentation of the results.

A "Total Base Coverage Level" (TBCL) for each of the four Grids was determined by multiplying the Base County Value (BCV) of hay acreage by the 150 percent PF to adjust for land quality. RMA has established Base County Values for hay land at all the four sites to be $148.60 per acre resulting in the TBCL:

1.) TBCL= $148.60 x 1 acre x 150% PF = $222.90.

Multiplication of the TBCL by alternative CL's gives Dollars of Insurance Protection (DIP) available for the four locations. That is:

2.) DIP_i = TBCL x % Insurance CL_i

for i defining the CL of 70 to 90 percent.

At 70 percent CL, this would mean $156.03 Dollars of Insurance Protection ($222.90 x .70). Table 1 lists the DIP levels estimated for the alternative CL's at the four Experiment Station sites. These values reflect the protection offered based the historic rainfall time series from 1948.

Insurance Premiums

Intervals within a Grid are insured based on historic rain shortfall risk for hay production. This is reflected in the insurance premiums charged per Interval based on all climate phases. The costs of the premiums charged for the RI insurance are subsidized by the federal government at 64 percent of the 70 percent and 75 percent, 59 percent of the 80 percent and 85 percent and 55 percent of the 90 percent Coverage Levels.

Insurance costs are calculated by multiplying the dollars of insurance protection by the "Base Premium Rate" by the farmer's share of the insured acreage. The Base Premium Rates are listed in Table 2. Protection estimates calculated for this analysis assume a 100 percent share to the producer.

Net Dollars of Insurance Protection

Net Dollars of Insurance Protection (after subsidies) for hay land were estimated for the four Experiment Station sites. These were calculated as:

3.) Unsubsidized Premium (UPDij) = DIPi x 100% Share x Base Premium Rate

As estimated above, for Headland at a 70 percent Coverage Level for example this would mean a DIP of $156.03. The DIP multiplied by producer's share and then by the Base Premium Rate would require the payment of an unsubsidized premium of $5.60 per acre.

$156.03 x 100% share x 3.59% = $5.60

The amount due from the producer would be net of the government subsidy.

4.) Producer Premium Due (PPDij) = UPDij - (UPDij x Subsidy)

As an example, after applying a 64 percent subsidy, the amount due from a producer would be $2.02 per acre for 70 percent CL at 150 percent of normal productivity (PF) in Interval I in Headland.

$5.60 x .64 subsidy rate = $3.58

$5.60 - $3.58 = $2.02 per acre

Finally, the resulting level of protection would be net of the PPD:

5.) Net DIPij = DIPij - PPDij

Where j = Intervals 1 to 6 at site i.

For Headland at a 70 percent CL this would mean a Net DIP of:

$156.03 - $2.02 = $154.01 per acre.

Net DIP's for alternative Intervals for 150 percent PF at the study sites did not vary greatly within coverage level for the four sites. At the 70 percent CL Net DIP ranged from approximately $150 to $155 depending on the Interval. For each increase of 5 percent in CL Net DIP increased by approximately $10 per acre.

Probabilities of Loss and Payoff

The higher the probability of significant rain shortfall the more compelling should be the case for purchasing RI. Using Simetar©, probability density estimates of rainfall shortages for average climate and then for distinct ENSO phases were developed for the four study sites for each two-month Interval covered by RI insurance (NOAA historic data http://prfri-rma-map.tamu.edu/). Estimates of the probabilities by which a Final Grid Index (FGI) would fall below Coverage Levels (and by how much below) for all climate and the distinct ENSO phases were used to determine potential payoffs from the RI.

Interpretation of the dollar payoffs should not be confused with what a producer might receive in any specific year. The probabilities of collecting on the insurance are generally lower than 50 percent (but with some exceptions) for all intervals regardless of climate phase. And, in fact, probabilities of collecting are indicated to be zero at Headland during an El Nino for some Intervals and coverage levels.

Expected Values

Expected value of payoffs are calculated as the probability of collecting on the insurance times the Net Dollars of Income Protection. As such, this number does not reflect what a producer would actually receive each year but only the probability conditioned protection offered for alternative Intervals and under alternative climate conditions based on the historic data.

Expected values or payoffs of RI insurance at various CL's for maximum levels of Net DIP were estimated for all climate phases and then for specific ENSO events. These were estimated as:

6.) EV(NDIPijk) = (Probability of RI less than CLijk) x (Net DIPij)

For all i and j where k = ENSO phase.

Expected values of the insurance over all ENSO climate phase are shown in Tables 3 through 6.

Results

There does not appear to be a consistent pattern of difference between estimated expected payoffs from the insurance based on averages over all climate events and individual ENSO events between the four sites. However within the sites differences do seem to exist between the payoffs averaged over all climate events and specific ENSO phases. There are also cases where optimal indemnity periods vary depending on CL. Tables 3-6 show the expected payoff results by Coverage Level and Interval for the four study sites. Table 7 summarizes these results.

At Belle Mina, the two indemnified Intervals with the highest payoff based on all climate events are February-March and December-January. In contrast, examining the expected payoff during specific ENSO phases shows that during a La Niña event the highest payoff comes from indemnifying August-September and October-November. Payoffs based on Neutral year climate data varies somewhat from the all climate results showing the highest returns during February-March and October-November instead of December-January. El Niño results shows the highest expected payoffs in April-May for 70 percent, 75 percent, and 80 percent coverage and February-March for the 85 percent and 90 percent CL's and December-January for all CL's.

Chilton results mirrors all climate phase results during Neutral years and during August-September in a La Niña year. The other optimal indemnity period during a La Niña differs from the overall climate result. During an El Niño the highest expected payoff comes from indemnifying April-May and October-November Intervals.

Fairhope results show that the two intervals with the highest expected payoff based on all climate events are April-May and October-November. Specific climate phase results are consistent with the overall climate expected payoff in October-November except in the case of La Niña at a 70 percent CL. During La Niña the optimal payoff intervals are also consistent with the all climate results during April-May. Neutral year optimal intervals include June-July and El Niño years August-September. During an El Niño event, expected payoffs are highest during August-September and the October-November.

Headland results show all climate phase payoffs to be highest during April-May and October-November. La Niña and Neutral years results agree with the overall optimal climate payoff results during October-November. The highest payoff interval during a La Niña event is December-January but for the Neutral years it is June-July. El Niño specific results also list April-May as one of the highest payoff intervals but splits results on the second highest payoffs between December-January at 70 to 80 percent CL and August-September at 85 and 90 percent CL.

Conclusions

Differences shown in optimal expected returns between the specific La Niña, Neutral and El Niño ENSO phases indicate that payoffs may be higher if producers select periods to indemnify based on individual climate phases, particularly during La Niña events. The best two intervals to indemnify based on specific ENSO phase vary, but not in all cases will differ from indemnification based on the average of all climate phase results. A consistent result for all sites indicate that during El Niño years, returns will be less than expected in comparison to results obtained based on average rainfall over all climate events. This is not unexpected in that El Niño years are often wetter than normal during critical growth periods.

Expected payoffs differ by ENSO phase and specific ENSO phase provides more accurate information on payoffs to managers than does payoff based on the average climate (all ENSO phase) data used by RMA. Management decisions based on selecting specific ENSO phase optimal Intervals in some cases increase expected payoffs and in others show that the results may be less than expected. Information provided in this study should help managers condition their expectations to more realistic expected results from the purchase of this insurance. Implications from this study also exist for setting actuarial rates based on specific ENSO phase.

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Table 1. Estimated total hay Dollar Income Protection (DIP) provided under alternative insurance Coverage Levels at 150 percent PF for all ENSO phases

Coverage Level	Alabama DIP
70%	$156.03
75%	$167.18
80%	$178.32
85%	$189.47
90%	$200.61

Table 2. Premium rates for alternative intervals and study sites at alternative coverage levels

Location	Interval	70%	75%	80%	85%	90%
Belle Mina	1	3.66%	5.12%	6.84%	8.79%	10.93%
Belle Mina	2	3.40%	4.81%	6.49%	8.41%	10.54%
Belle Mina	3	3.58%	4.77%	6.37%	8.28%	10.40%
Belle Mina	4	6.98%	8.61%	10.04%	11.38%	12.79%
Belle Mina	5	7.40%	9.27%	11.26%	13.03%	14.71%
Belle Mina	6	6.52%	8.37%	10.25%	11.96%	13.83%
	Interval	**70%**	**75%**	**80%**	**85%**	**90%**
Chilton	1	4.28%	5.82%	7.61%	9.60%	11.76%
Chilton	2	5.88%	7.82%	9.89%	12.05%	14.24%
Chilton	3	5.08%	6.87%	8.78%	10.86%	13.03%
Chilton	4	4.93%	6.27%	7.63%	9.16%	10.85%
Chilton	5	5.68%	7.40%	9.32%	11.39%	13.60%
Chilton	6	5.19%	6.85%	8.72%	10.74%	12.85%
	Interval	**70%**	**75%**	**80%**	**85%**	**90%**
Fairhope	1	4.65%	6.18%	7.73%	9.56%	11.32%
Fairhope	2	12.72%	14.81%	16.57%	18.14%	19.74%
Fairhope	3	3.55%	4.99%	6.87%	9.00%	11.12%
Fairhope	4	5.54%	7.10%	8.96%	11.00%	13.17%
Fairhope	5	8.45%	10.60%	13.07%	15.66%	18.03%
Fairhope	6	4.85%	6.48%	8.32%	10.33%	12.21%
	Interval	**70%**	**75%**	**80%**	**85%**	**90%**
Headland	1	3.59%	4.67%	6.29%	7.76%	9.34%
Headland	2	8.30%	9.80%	11.43%	13.01%	14.69%
Headland	3	3.38%	4.71%	6.24%	8.14%	10.24%
Headland	4	3.17%	4.44%	6.06%	7.94%	10.04%
Headland	5	10.47%	12.79%	14.99%	17.13%	19.44%
Headland	6	6.13%	7.79%	9.74%	11.57%	13.50%

Table 3. Expected payoff (EV) per acre by ENSO phase for Belle Mina

Interval CL	Feb-Mar	Apr-May	Jun-July	Aug-Sep	Oct-Nov	Dec-Jan
All Climate	**$EV**	**$EV**	**$EV**	**$EV**	**$EV**	**$EV**
70%	$37.94	$31.36	$31.36	$30.78	$29.95	$40.59
75%	$49.13	$42.00	$41.62	$38.12	$40.46	$50.33
80%	$61.68	$54.17	$53.48	$46.41	$52.74	$60.65
85%	$75.54	$67.79	$67.01	$56.26	$67.05	$72.06
90%	$89.73	$81.99	$81.43	$67.32	$82.27	$83.76
La Niña	**$EV**	**$EV**	**$EV**	**$EV**	**$EV**	**$EV**
70%	$19.95	$20.25	$23.94	$54.06	$36.03	$27.66
75%	$26.86	$31.14	$33.01	$65.15	$45.82	$35.42
80%	$34.70	$44.59	$44.72	$76.90	$56.44	$43.92
85%	$43.50	$60.36	$59.91	$89.97	$68.27	$53.48
90%	$52.84	$77.41	$78.07	$103.36	$80.35	$63.38
Neutral	**$EV**	**$EV**	**$EV**	**$EV**	**$EV**	**$EV**
70%	$44.82	$31.65	$31.42	$16.60	$23.20	$47.90
75%	$57.27	$41.97	$42.40	$21.24	$35.26	$57.24
80%	$71.10	$53.37	$54.98	$26.53	$50.79	$66.98
85%	$86.21	$65.83	$69.12	$33.05	$69.81	$77.81
90%	$101.39	$78.75	$84.00	$40.90	$90.50	$88.92
El Niño	**$EV**	**$EV**	**$EV**	**$EV**	**$EV**	**$EV**
70%	$20.61	$31.25	$24.48	$12.11	$19.92	$36.80
75%	$34.12	$40.65	$32.45	$16.09	$27.03	$47.77
80%	$50.32	$51.30	$41.50	$25.02	$35.41	$59.81
85%	$70.17	$63.26	$51.72	$36.40	$45.60	$73.45
90%	$93.99	$75.80	$62.63	$49.90	$57.29	$87.88

Table 4. Expected payoff (EV) per acre by ENSO phase for Chilton

Interval CL	Feb-Mar	Apr-May	Jun-July	Aug-Sep	Oct-Nov	Dec-Jan
All Climate	$EV	$EV	$EV	$EV	$EV	$EV
70%	$36.65	$42.75	$42.01	$23.76	$35.12	$31.19
75%	$47.65	$52.96	$52.90	$32.01	$45.48	$40.92
80%	$59.94	$63.79	$64.42	$42.57	$56.98	$52.04
85%	$73.54	$75.60	$76.70	$55.70	$69.95	$64.67
90%	$87.50	$87.52	$88.85	$70.68	$83.56	$78.01
ENSO	La Niña	La Niña	La Niña	La Niña	La Niña	La Niña
70%	$35.94	$25.82	$28.97	$39.29	$29.62	$32.22
75%	$45.65	$34.16	$35.72	$48.19	$38.33	$41.08
80%	$56.23	$43.63	$43.05	$57.94	$47.95	$50.77
85%	$67.80	$54.43	$51.26	$68.85	$58.75	$61.46
90%	$79.56	$65.87	$59.95	$80.35	$70.15	$72.46
ENSO	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
70%	$41.85	$47.05	$53.02	$10.89	$23.98	$39.59
75%	$53.61	$58.35	$66.30	$18.92	$33.19	$49.22
80%	$66.56	$70.19	$80.11	$30.64	$44.60	$59.57
85%	$80.82	$82.91	$94.61	$46.34	$63.81	$70.97
ENSO	ElNiño	ElNiño	ElNiño	ElNiño	ElNiño	ElNiño
70%	$16.46	$41.72	$24.44	$12.73	$34.45	$7.11
75%	$21.70	$51.20	$33.36	$19.70	$42.18	$12.72
80%	$31.12	$61.27	$43.56	$29.04	$50.47	$22.07
85%	$42.62	$72.31	$55.06	$40.79	$59.66	$36.93
90%	$55.64	$83.49	$67.09	$54.57	$69.13	$57.44

Table 5. Expected payoff (EV) per acre by ENSO phase for Fairhope

Interval	Feb-Mar	Apr-May	Jun-July	Aug-Sep	Oct-Nov	Dec-Jan
CL						
All Climate	SEV	SEV	SEV	SEV	SEV	SEV
70%	$38.49	$49.20	$35.59	$33.11	$47.67	$24.13
75%	$47.76	$58.05	$46.86	$43.33	$58.29	$33.63
80%	$57.70	$67.05	$59.30	$55.13	$69.04	$45.08
85%	$68.66	$77.20	$72.85	$68.76	$80.52	$58.65
90%	$80.29	$87.22	$86.69	$83.45	$91.62	$73.74
ENSO	La Niña	La Niña	La Niña	La Niña	La Niña	La Niña
70%	$49.91	$61.57	$22.76	$20.52	$48.91	$27.92
75%	$61.33	$71.17	$34.94	$27.23	$61.74	$41.13
80%	$73.18	$80.56	$49.80	$35.26	$74.76	$56.83
85%	$85.91	$90.96	$66.96	$44.82	$88.31	$74.77
90%	$99.15	$100.83	$85.18	$55.47	$101.00	$94.08
ENSO	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
70%	$43.32	$46.90	$49.66	$26.59	$51.07	$20.41
75%	$54.00	$55.67	$61.34	$38.98	$60.80	$29.23
80%	$65.52	$64.66	$73.41	$53.34	$70.62	$39.91
85%	$78.09	$74.80	$85.99	$69.75	$81.25	$52.74
90%	$91.09	$84.76	$98.33	$87.61	$91.66	$67.29
ENSO	El Niño	El Niño	El Niño	El Niño	El Niño	El Niño
70%	***	$27.33	***	$47.13	$32.57	$14.75
75%	***	$34.38	$19.60	$57.33	$40.37	$21.05
80%	***	$42.21	$26.37	$68.00	$48.69	$28.82
85%	***	$51.45	$36.95	$79.47	$58.01	$38.29
90%	***	$61.20	$49.21	$90.85	$67.56	$49.11

*** Probability = 0

Table 6. Expected payoff (EV) per acre by ENSO phase for Headland

Interval	Feb-Mar	Apr-May	Jun-July	Aug-Sep	Oct-Nov	Dec-Jan
CL						
All Climate	$EV	$EV	$EV	$EV	$EV	$EV
70%	$29.31	$39.59	$29.19	$20.97	$48.77	$36.16
75%	$38.00	$48.83	$39.81	$31.08	$58.15	$45.66
80%	$47.92	$58.93	$52.45	$43.94	$67.71	$55.99
85%	$59.51	$70.45	$67.28	$59.25	$77.86	$67.54
90%	$72.34	$82.42	$83.46	$75.97	$87.56	$79.50
ENSO	La Niña	La Niña	La Niña	La Niña	La Niña	La Niña
70%	$43.33	$36.19	***	$23.80	$63.23	$46.47
75%	$53.24	$44.84	***	$31.58	$75.06	$58.28
80%	$63.84	$54.24	$25.44	$41.00	$86.59	$70.72
85%	$75.71	$64.87	$46.93	$52.41	$98.71	$84.26
90%	$88.50	$75.86	$73.24	$65.55	$109.67	$97.87
ENSO	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
70%	$30.20	$39.80	$49.82	$16.97	$51.92	$33.45
75%	$40.60	$49.55	$63.07	$28.40	$60.92	$41.47
80%	$52.49	$60.17	$77.01	$43.35	$69.87	$50.36
85%	$66.12	$72.20	$91.54	$61.27	$79.61	$60.59
90%	$80.92	$84.67	$105.73	$80.56	$88.78	$71.51
ENSO	El Niño	El Niño	El Niño	El Niño	El Niño	El Niño
70%	***	$32.92	***	***	$20.84	$21.57
75%	***	$40.70	***	$22.78	$27.00	$29.31
80%	***	$49.14	***	$35.11	$33.93	$38.22
85%	***	$58.71	$21.46	$50.04	$42.05	$48.49
90%	$21.92	$68.65	$32.68	$66.68	$50.65	$59.43

*** Probability = 0

Table 7. Highest expected payoffs (EV) per acre for two indemnification periods

Belle Mina				
70-80% CL	All Climate	La Niña	Neutral	El Niño
	Feb-Mar	Aug-Sep	Feb-Mar	Apr-May
	Dec-Jan	Oct-Nov	Dec-Jan	Dec-Jan
85% CL	All Climate	La Niña	Neutral	El Niño
	Feb-Mar	Aug-Sep	Feb-Mar	Feb-Mar
	Dec-Jan	Oct-Nov	Dec-Jan	Dec-Jan
90% CL	All Climate	La Niña	Neutral	El Niño
	Feb-Mar	Aug-Sep	Feb-Mar	Feb-Mar
	Dec-Jan	Oct-Nov	Oct-Nov	Dec-Jan
Chilton				
70-90% CL	All Climate	La Niña	Neutral	El Niño
	Apr-May	Feb-Mar	Apr-May	Apr-May
	Jun-Jul	Aug-Sep	Jun-Jul	Oct-Nov
Fairhope				
70% CL	All Climate	La Niña	Neutral	El Niño
	Apr-May	Feb-Mar	Jun-Jul	Aug-Sep
	Oct-Nov	Apr-May	Oct-Nov	Oct-Nov
75-90% CL	All Climate	La Niña	Neutral	El Niño
	Apr-May	Apr-May	Jun-Jul	Aug-Sep
	Oct-Nov	Oct-Nov	Oct-Nov	Oct-Nov
Headland				
70-80% CL	All Climate	La Niña	Neutral	El Niño
	Apr-May	Oct-Nov	Jun-Jul	Apr-May
	Oct-Nov	Dec-Jan	Oct-Nov	Dec-Jan
85% CL	All Climate	La Niña	Neutral	El Niño
	Apr-May	Oct-Nov	Jun-Jul	Apr-May
	Oct-Nov	Dec-Jan	Oct-Nov	Aug-Sept
90% CL	All Climate	La Niña	Neutral	El Niño
	Jun-Jul	Oct-Nov	Jun-Jul	Apr-May
	Oct-Nov	Dec-Jan	Oct-Nov	Aug-Sept