Managing Forage Production Risk in the Western States: The Role of PRF Rainfall Index Insurance

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Introduction

In the Western United States ranching is a risky business. Forage losses from natural hazards (severe drought, insect infestation, etc.) are frequent. Livestock mortality and morbidity result from of adverse winter weather, summer heat, livestock diseases, and predation. The link between ranch-level production losses and commodity prices is weak. At the market level, when production is relatively low prices tend to be relatively high, but an individual rancher may experience low levels of production because of local adverse production conditions when commodity prices are also low.

Ranchers use a wide variety of techniques to manage risk. They develop and implement risk management strategies to reduce the chances that they will suffer livestock production and financial losses. Ranchers use many production techniques to prevent or limit livestock and forage production losses. Some risk management practices are highly visible (for example, inoculation against diseases and hay production using pivot irrigation). Other risk management practices may not be so visible (for example, investment income diversification though financial asset diversification).

Hay is the primary forage harvested for winter-feeding by ranchers in the more northern states in the Western United States. Hay production is subject to considerable production risk. Some ranchers are only able to produce upland hay and, in drought years, either have no production or experience substantial production losses. Other ranches may produce irrigated hay, often alfalfa, with irrigation water diverted from a stream or from a small storage reservoir. In some years, lack of snow accumulation may limit or even preempt irrigation options, reducing hay crops because of lower yields per cutting and/or fewer cuttings. In other years, even when ranchers use best management practices, forage production may be relatively low because of extreme drought and heat, plant disease, or insect infestations. Ranch managers often address the possibility of limited forage production in a particular crop year by holding relatively large hay inventories, often carrying inventories that exceed their needs for feeding in wintertime. This strategy usually guarantees that sufficient forage will be available if the winter feeding period is longer and/or feeding requirements higher than usual because of atypically cold weather and extended periods of snow cover that restrict access to grazingland. It also provides carryover stocks for the next year if winter feeding requirements are more typical. If forage production is limited in the current production year, the ranch will likely have some carryover hay from prior years in its inventory available to feed its livestock.

Many ranch managers also manage forage production risks by using stocking rates that maintain rangeland productivity and leave useable forage on the grazingland after the current grazing period, especially when precipitation is adequate or above average. On grazingland standing forage then serves as the ranch's inventory for subsequent grazing periods when range production may be lower than expected because of limited precipitation, excessive heat, and other adverse growing conditions.

Ranchers also lease public lands for grazing purposes. When forage production is below expected levels on rangeland leased from public agencies, those agencies may restrict grazing use. Restrictions often include lower than normal stocking rates or early dates for pulling livestock off public grazinglands. Some ranch managers may acquire access to additional forage through ownership of grazingland by leasing a mix of rangeland types that provide forage in different seasons to limit grazing losses due to drought.

Risk management strategies for hay production and forage raised on grazingland may also involve crop insurance products. Some ranchers opt not to purchase any kind of insurance, choosing instead to ***self insure.*** Another strategy is to use ***single peril*** crop insurance products to prevent losses from specific cause such as hail, an option provided in some states through state-managed hail and other single peril insurance programs.

Increasingly, however, ranchers and farmers have utilized federally-subsidized crop insurance products to manage production risks. All such products are approved by the Federal Crop Insurance Corporation (FCIC). The insurance products are sold and serviced by private crop insurance agents and companies, but the Risk Management Agency (RMA) of the United States Department of Agriculture (USDA) oversees all aspects the day to day operations of the federal crop insurance program. Ranchers in the western United States now have access to a range of federally subsidized crop insurance products to facilitate their ability to manage hayland and grazingland production risks.

Many of these insurance plans address multiple perils such as drought, hail, fire, and insect infestation. In recent years, however, ranchers in western states have begun to use a single peril insurance product, the ***Pasture, Rangeland, Forage Rainfall Index*** (**RI- PRF**) plan to provide protection against losses of hay and forage production caused by a single peril, inadequate precipitation.

Since the mid-1990s, ranchers in most western states have been able to purchase federally subsidized, area based multiple peril crop insurance products. These products provided indemnities when the ***area*** in which ranch operation was located experienced low per acre crop yields (Group Risk Insurance Plans). Historically, the ***area*** has been the county in which a ranch's cropland or grazingland is located.

The ***Pasture, Rangeland, Forage Rainfall Index*** **(*RI-PRF*)** plan that is described, illustrated, and evaluated for its usefulness to ranchers in this policy paper is also an area-based plan. However, **RI- PRF** plans differ from other area-based plans in two important ways.

First, the risk against which insurance is provided is lack of precipitation, a ***single peril***, not area-wide yield shortfalls caused by multiple perils. Second, coverage is based on a much smaller ***area***. **RI- PRF** plans offer insurance in areas identified by ***grids.*** Each of these ***grids*** is defined in terms of latitude and longitude - ***0.25 degrees in latitude by 0.25 degrees in longitude*** ---which translates to approximately 17 by 17 miles at the equator but smaller areas at latitudes farther north. For most counties in the western states, a ***grid*** (around 12 miles by 12 miles) is far smaller than the county in which it is located.

The Pasture, Rangeland, Forage Rainfall Index Plan

The **Pasture, Rangeland, Forage Rainfall Index Plan,** (**RI- PRF**) has been offered as a pilot program in all counties in the 48 contiguous states since the beginning of the 2016 production year (Release No. RMA 15-138, *USDA Expands Forage Crop Insurance Option Nationwide for Livestock Producers*, Aug.15, 2015).

The intent of the plan is to help ranchers protect themselves against loss of forage used to feed livestock. Table 1 shows the extent to which the **Pasture, Rangeland, Forage Rainfall Index Plan has been used** by ranchers in western states since 2016, when the plan became available in all 48 contiguous states.[1] The information reported in Table 1 includes data on liability, total premium (payments by producers plus the subsidies provided by the federal government), premium subsidies, and indemnities received by ranchers.

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[1] Prior to 2016, a similar plan based on a vegetation.

Similar information is reported in the appendix for each of the eleven states.

It should be noted that, even though the focus in this briefing paper is grazingland forage production, the data in Table 1 include **RI-PRF** plan information for all types of forage production, including grazingland production and irrigated hay production.

The **RI-PRF** plan is designed to insure against lost forage production caused by inadequate rainfall, as measured by a rainfall index that is based on the long-term, historical, average precipitation for the same area of land using data collected since 1948. Each grid, identified by a unique ***grid ID number***, has its own rainfall indexes. Those indexes are used as indicator variables for pasture, rangeland and hay production within that grid at different times of the year.

However, ranchers should be aware that the grid rainfall indexes ***do not measure, capture, or use the actual crop production of any individual producer or any of the actual production within the area in which a rancher uses the plan to insure against potential loss of forage***.

As discussed above, the **RI-PRF** plan uses a numbered grid system to cover the entire landscape in the 48 contiguous states of the United States. The plan uses rainfall information provided by the National Oceanic and Atmospheric Administration's (NOAA) Climate Prediction Center (CPC). NOAA defines each grid and the grids are not linked to any state, county or other geopolitical boundaries (for example, the area included in a grid may be located in multiple countries or multiple states and include high mountain and high plains pastures).

Precipitation data for each grid are reported for 11 two-month periods within any given year. These two-month periods are called ***index intervals.*** Historical NOAA data from 1948 to the present are used to construct a ***rainfall index*** for each ***index interval*** in each ***grid.***

The eleven ***index intervals*** are as follows: January and February; February and March; March and April; April and May; May and June; June and July; July and August; August and September; September and October; October and November; and November and December. In some grids, ranchers may not be able to obtain insurance in all index intervals because indexes are not provided for certain intervals.

Table 1: PRF-Rainfall Index Insurance in Eleven Western United States, 2016-2018*

Year	Liability ($)	Total Premium ($)	Premium Subsidy ($)	Producer Premium ($)	Indemnity ($)	Indemnity /Total Premium.	Indemnity. /Producer Premium
2016	315,005,644	71,036,885	38,523,710	32,513,715	57,819,643	0.81	1.78
2017	681,098,369	180,405,973	95,888,936	84,517,037	190,026,807	1.05	2.25
2018	966,000,459	249,927,508	133,963,923	115,963,590	275,348,798	1.10	2.37

* The eleven states include Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

For each insurance year, an ***Expected Grid Index*** value is established by NOAA for each interval in each grid using precipitation data collected from over 6,000 weather stations across the nation. The expected average value for each index in each interval is always defined as 100 (100 percent of expected precipitation). Thus, the ***Expected Grid Index*** represents the average precipitation for the **grid ID** during the index interval based on rainfall data reported by NOAA from 1948 to the present.

For each grid, in each index interval a ***Final Grid Index*** is calculated using data collected by NOAA which shows the estimated actual precipitation in that grid in the index interval of interest (for example, the grid index value for the April-May interval in 2018 is computed using rainfall data collected by NOAA in those two months).

The precipitation information reported by NOAA for each grid is not measured as the precipitation reported from a specific rain gauge. Each day NOAA obtains data from a minimum of four reporting stations that are closest to the center of the grid and that report data for that day. Different stations may be used from day to day because not all stations report weather data every day. Accordingly, the precipitation value reported for each grid is an interpolated value for the entire grid and cannot be traced to a single location point or reporting station.

Note, therefore, that the precipitation data used to construct **RI-PRF** precipitation indexes may not match the amount of precipitation recorded by an insured rancher at a specific location in any index interval.

A ***Final Grid Index*** of 100 represents **average** precipitation, an index **below 100** represents **below average** precipitation, and an index **above 100** represents **above average** precipitation. For example, an index value of 85 would indicate that precipitation was 15 percent below its expected level and an index value of 145 would indicate that precipitation was 45 percent above its expected level.

The **RI-PRF** insurance plan has the following basic characteristics. Insurance for forage loss under the **RI-PRF** plan requires a rancher to make a coverage level decision. A ***Trigger Index*** value is established in the insurance policy purchased by a rancher by multiplying the ***Expected Grid Index*** by the ***coverage level*** selected by the rancher.

The ***maximum coverage level*** available to the rancher is 90 (90% of expected precipitation) but a rancher may also select a lower coverage level. The rancher will receive an ***indemnity*** when the value of the ***Final Grid Index*** in an insured ***index interval*** is lower than the ***Trigger Index.***

As illustrated below, the rancher establishes the total ***liability*** against which ***RI-PRF*** insurance has been purchased through the ***coverage level*** she selects and a ***productivity factor*** (defined below) that she also selects. This amount (the liability for an insured unit of forage land) is defined by RMA as the ***policy protection per unit*** purchased by the rancher.

If there is a total loss of all forage (no rainfall takes place) the rancher receives an indemnity equal to the ***policy protection per unit*** for which she purchased the insurance coverage in each ***index interval*** covered by the policy. However, most often, while rainfall is well below normal and sufficiently low to trigger an indemnity payment, the ***Final Grid Index*** is positive. Thus, the indemnity the rancher receives for losses in an index interval covered by the policy is defined by multiplying ***policy protection per unit*** for that index interval by a ***payment calculation factor*.** The definition of the ***payment calculation factor*** is as follows:

Payment Calculation Factor* = (*Trigger Index* – *Final Grid Index*)/ *Trigger Index.

If the ***Final Grid Index*** is higher than or equal to the ***Trigger Index***, the ***payment calculation factor*** is set equal to zero and the rancher is not eligible to receive an indemnity for that ***index interval***.

The ***indemnity*** a rancher receives for forage losses in any ***index interval*** is defined as:

Indemnity = ***Payment Calculation Factor*** x ***Policy Protection per unit.***

For example, if the ***trigger index*** value is 90 and the ***final grid index*** value is 45, the ***payment factor*** will be (90 – 45)/90 = 0.5. If the ***policy protection per unit*** covered by the ***RI-PRF*** for the index interval is $10,000, the rancher will then receive an indemnity of $5,000 ($10,000 x 0.5) to compensate for any forage losses that occurred in that ***index interval***.

A rancher who is considering using a ***RI-PRF*** policy to insure against loss of forage needs to recognize that, because this plan is an area insurance plan and does not measure, capture or use any actual production, the rancher could experience ***significant forage losses but not receive an indemnity payment***. However, it is also possible for an eligible producer to receive ***an indemnity payment without suffering any loss of actual production***.[2] These concerns are likely to be important for ranchers when making decisions about whether to obtain ***RI-PRF*** coverage and the levels of coverage the rancher may obtain.

Key RI-PRF Plan Concepts

A rancher considering obtaining a ***RI-PRF*** insurance contract needs to understand the following concepts and their definitions. Insurance agents qualified to sell and service such insurance plans will be able to help ranchers understand these key elements of the insurance plans available to them.[3]

Ranchers will often want to insure an area of land that spans more than one grid. Thus, what constitutes contiguous land is an important concept. ***Contiguous*** means acreage in a county or grid that continues into an adjoining state, county or grid without interruption. Acreage separated by only a public or private right-of-way, waterway, or irrigation canal can be considered contiguous.

The expected value of forage when forage production is viewed as occurring at normal levels is also an important concept. The ***county base value per acre*** means FCIC's (Federal Crop Insurance Corporation) determined value of the crop in the county as contained in the Actuarial Documents (for the insurance product). It is a value that plays a major role in determining the dollar amount of insurance coverage for forage loss (the liability against which the producer purchases insurance).

The amount and cost of the insurance being purchased under a ***RI-PRF*** plan is affected by the ***coverage level*** selected by the rancher. As discussed above, the ***coverage level*** is the percentage selected by the insured rancher from a range from specified in the ***Actuarial Documents*** for the ***RI-PRF*** insurance plan. The ***Coverage level*** options available to a rancher are 70,75,80,85, and 90 percent. A producer selects one of these options for forage land insured under any given ***RI-PRF*** contract.

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[2] These concerns are described by the USDA Risk management Agency in the following unnumbered document: ***Summary Overview of Rainfall Index Insurance Plan for Pasture, Rangeland, and Forage*****,** available on the RMA website.

[3] These definitions are based on the definitions provided in the USDA RMA document *Rainfall and Vegetation Index Common Policy, 18-Rivi,* undated and available on the RMA website.

The ***expected grid index*** is the grid index determined by FCIC. For ***RI-PRF*** policies, this value is the mean accumulated precipitation by index interval, calculated by using NOAA's interpolated historical gridded precipitation data, or successor data, normalized and expressed as a percentage such that the mean is 100. The data used to calculate the ***expected grid index*** is conclusively presumed to be accurate.

The ***final grid index*** is determined by FCIC. As discussed above, the value of this index is NOAA's interpolated current gridded precipitation data or successor data, for each grid ID and index interval, expressed as a percentage. The data used to calculate the ***final grid index*** is conclusively presumed to be accurate and the final grid index value cannot be challenged.

A ***grid*** is an area identified by longitude and latitude used to determine the expected grid index, the final grid index, premium and indemnity. For Rainfall Index policies, the grid is a 0.25 degree gridded area, or successor, established by NOAA (at the equator, the grid size is identified as a 17 by 17 kilometer area).

The ***grid identification number (grid ID)*** is a specific number assigned to each grid.

An ***insurable loss*** occurs when the ***final grid index*** is less than the ***trigger grid index***.

The ***point of reference*** for a grid is the location provided by the insured rancher for the insured acreage. The ***point of reference*** must be obtained using the maps contained on RMA's website that identifies where each grid is located.

A rancher may own or lease grazingland that produces forage of either higher or lower value than estimated by FCIC, as reflected in the ***county base value per acre*** for the county in which the rancher's grazingland is located. The rancher can select a ***productivity factor*** of between 60% and 150% to represent the operation's forage productivity to decrease or increase the insured value of their forage on a per acre basis.

For example, suppose that the FCIC ***county base value per acre*** is $8.00 per acre (assessed on a countywide basis by FCIC), but the rancher assesses that the insured grazingland produces forage valued at $10 per acre. The rancher then has the option of selecting a ***productivity factor*** of 125 to reflect the fact that the insured land produces $10 of forage per acre; that is, the area being insured is 25% more productive than the estimated countywide productivity of grazingland.

A rancher may have a 100 percent share in the grazingland being insured (owning the land or cash leasing the land, for example). Alternatively, the rancher may have only a partial interest in the forage produced on the grazingland. ***Share*** means the insured's insurable interest in the crop as an owner, operator, or tenant.

Trigger grid index means the result of multiplying the ***expected grid index*** by the ***coverage level*** selected by the insured rancher.

Unit means the number of acres insured under the contract by crop and intended use (grazing or forage harvested for hay), index interval, share, irrigated practice, organic practice, and county within or assigned to a grid.

The above concepts are fundamental in any assessment of how ranchers can use ***RI-PRF*** insurance contracts in developing risk management strategies for their operation.

Using PRF Rainfall Index Insurance to Manage Forage Production Risk

How might a rancher evaluate whether or not ***RI-PRF*** would be useful to his ranching operation in managing some of the production risks associated with forage production on the ranch? The starting point is to locate the ***RI-PRF*** decision software on the USDA RMA website.

Ranchers can locate the software at https://prodwebnlb.rma.usda.gov/apps/prf.

First, the rancher must select a ***point of reference*** identified by longitude and latitude that most effectively represents the location of the acreage used for forage production that he wants to insure, with the binding condition that some of the ***contiguous*** insured acreage must be located within the grid that is chosen. This ***point of reference*** determines the ***grid ID*** for the grid whose rainfall index forms the basis for the insurance the rancher is considering.

Contiguous forage acreage, especially grazingland, often falls into more than one grid. Consider a situation where a rancher has ***contiguous*** grazingland that spans portions of two adjacent grids (A and B). The rancher has the following three options. He can insure all the grazingland acreage by either using the selected index intervals in grid A, or the selected index intervals in grid B. Alternatively, the rancher can insure the grazingland acres in Grid A using Grid A's index intervals and the grazingland acres in Grid B using Grid B's index intervals.

A rancher with two or more separate and non-contiguous areas of grazingland for which insurance is desired must insure each separate area in the grid (or grids) in which each non-contiguous areas of grazingland is located.

Each ***grid*** has its own unique code, as defined in the actuarial document for ***RI-PRF*** policies. Historical data on the values of the rainfall indexes for the grid are available to the rancher (and/or the rancher's insurance agent) for each two-month ***index interval*** from 1948 until two years prior to the current insurance year.

As illustrated in the examples that follow, the grid-specific historical data on the value of the rainfall indexes for each two-month interval can be used by the rancher to assess how often a specific rainfall index insurance policy would have provided an indemnity. The data can also be used to calculate the indemnities would have been paid had the land been insured in any given index interval at each available coverage level in previous years.

RI-PRF insurance is applicable to crops defined as pasture, rangeland or forage for ***two crop types***. The two ***crop types*** are identified as ***grazingland*** and ***hayland. Grazingland*** is an area of forage established on land suitable and intended for grazing by livestock. ***Hayland*** is an area established on land suitable and intended for haying.

Ranchers are encouraged to consider the intent of these definitions. For instance, if a hayfield has a perimeter fence surrounding 360 acres but 20 acres have outcroppings of rocks, within the field only 340 acres could be insured. The remaining 20 acres cannot be harvested mechanically for hay and are considered uninsurable.

A rancher does not have to insure all the acres of hayland or grazingland in a grid. The rancher is free to choose the acres he wants to insure.

As discussed above, the crop year for ***RI-PRF insurance*** is divided into the following eleven two-month intervals: January and February; February and March; March and April; April and May; May and June; June and July; July and August; August and September; September and October; October and November; and November and December. Further, note that while not all eleven ***index intervals*** may be available for insurance purposes in all grids, they are available in many grids.

A producer must select at least two ***index intervals*** to insure their eligible acres. Each selected ***index interval*** must contain a minimum of 10 percent of the acreage eligible for enrollment, but cannot contain more than 70 percent of the eligible acreage to be enrolled.

Further, the selected ***index intervals*** cannot overlap; for example, a producer cannot insure against loss in the May-June interval and the June-July interval. Nor can they be consecutive. For example, insurance cannot be purchased for both April-May and June-July, but could be purchased for April-May and July-August.

The ***dollar value*** of the insurance per acre is the product of the ***county base value***, solely determined by RMA, multiplied by the ***coverage level*** and ***productivity factor*** selected by the rancher***. County base values*** are specified by RMA per acre of grazingland and per acre of hayland.

A producer can choose a ***coverage level*** of 70,75,80,85, or 90 percent of the ***county base value*** for each crop type being insured. Producers are required to insure all grids for each crop type in a county at the same ***coverage level.*** As discussed above, the ***productivity factor*** selected by the rancher can range from 60% to 150% of the county base value.

Once the per acre ***dollar value*** is determined, the ***policy protection per unit*** can be established. The ***policy protection per unit*** is the per acre ***dollar value*** times the insured acres in the unit times the ***producer's share*** of the unit. A producer with insured acres in two units will have two ***policy protection per unit*** values.

Policy protection is the sum of the ***policy protection per unit*** values across all insured units.

Ranchers will be concerned about how much ***RI-PRF*** policies will cost them (out of their own pockets) and when and what amounts of indemnity payments they will receive for any insured losses. The next two sections explain the calculations for ***RI-PRF*** insurance premiums and ***RI-PRF*** indemnities.

Premium Calculations

Premium calculations for the **RI-PRF** insurance plan are similar to those for any other group risk insurance plan. The ***premium rate*** is quoted as a dollar amount per $100 of insurance liability (the maximum indemnity under the provisions of the contract). Premium subsidy rates are similar to those in other group risk products and subsidy rates decrease as ***coverage levels*** increase. The rancher will pay a producer premium for coverage equal to the difference between the total premium for the contract and the subsidy paid by the federal government.

Table 3. Premium Subsidy Rates and Administration Fees by Coverage Level

Coverage Level (%)	Subsidy Rate (%)	Administrative Fee per Contract
70	59	$30
75	59	$30
80	55	$30
85	55	$30
90	51	$30

The premium calculations are as follows:

Total Premium per Unit = Dollar Protection per Acre x Insured Acres/Unit x ***Premium Rate per $100 insurance.***

Premium Subsidy per Unit = Total Premium per Unit x S***ubsidy Rate.***

Producer Premium per Unit = Total Premium per Unit - ***Premium Subsidy per Unit.***

RI-PRF Rainfall Index Insurance Indemnities:

As discussed above, indemnities are paid to an insured producer when the ***final grid index*** falls below the ***trigger grid index.*** If an insured producer wants a relatively high ***trigger grid index*** the insured producer will select a relatively high ***coverage level.***

The amount of the indemnity is then determined subsequent to the calculation of the ***Payment Calculation Factor*** which is defined as follows:

Payment Calculation Factor = (Trigger Grid Index Final Grid Index) / (Trigger Grid Index – Final Grid Index).

The ***Indemnity per Unit = Policy Protection per Unit* x *Payment Calculation Factor.***

Final Grid Index values are calculated by ***RMA*** soon after the close of each index interval so that insurance indemnities can be made to the insured producer in a timely manner.

Two Examples of RI-PRF Decision Issues for Wyoming Ranchers

Consider the following two examples that illustrate the issues ranchers must consider when evaluating ***RI-PRF*** as a risk management tool. Tables 4 and 5 show the ***final grid index*** values for each of eleven ***index intervals*** for two example grids over the fifteen-year period 2004 to 2018, as reported by RMA in the RMA ***RI-PRF*** decision tool on the RMA web site. The first is for a grid located in Fremont County and the second for a grid located in Goshen County.

The years in which for each index interval the final grid index falls below 90, the maximum coverage level available to producers are identified in red. These are years in which an indemnity would be available to a rancher who insured against loss of forage at the maximum coverage level of 90%. Over the fifteen-year period, the frequency with which indemnities are paid within a given grid varies by index interval.

For example, in Fremont County, forage land insured in the January-February index interval, as shown in Table 4, would have received an indemnity in three of the fifteen years, but land insured in the July-August index interval would have been eligible for indemnity payments in eight of the fifteen years. In contrast, land insured under a 90% coverage level in the Goshen County representative grid in the January-February index interval, as shown in Table 5, would have received an indemnity in ten of the fifteen years. Land insured in the Goshen County representative grid in the July-August index interval would have received a payment in seven of those years.

Table 4: Values of the Rainfall Index for a Representative Grid (ID 27687) in Fremont County, Wyoming for each two-month insurance interval from 2004 to 2018

Year	Jan-Feb	Feb-Mar	Mar-Apr	Apr-May	May-Jun	Jun-Jul	Jul-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec
2018	255.8	228.2	**79.8**	156.5	169.3	89.8	**72.2**	**17.5**	**44.2**	126.1	153.8
2017	384.7	519.0	500.8	219.9	**60.9**	**33.0**	103.5	222.4	169.8	108.3	179.7
2016	138.3	366.9	391.7	220.8	102.5	25.9	53.6	194.3	245.1	214.7	229.5
2015	232.0	207.3	**88.9**	196.5	186.6	98.1	93.8	**13.4**	**30.7**	126.7	168.8
2014	126.4	99.7	**57.3**	**40.0**	**75.5**	121.6	205.8	187.6	**69.9**	**53.1**	158.5
2013	171.2	**88.8**	**86.6**	100.8	**58.8**	**27.0**	**43.4**	287.4	377.0	198.3	**44.7**
2012	113.4	**74.1**	**37.7**	**56.1**	**38.2**	**8.2**	**15.5**	**12.6**	28.5	59.9	93.0
2011	173.8	98.5	**32.4**	187.0	185.9	**41.1**	**50.4**	**56.0**	145.5	201.3	99.8
2010	117.2	153.6	170.0	190.7	178.1	103.9	**52.6**	**28.8**	**16.1**	**38.2**	104.1
2009	**33.7**	147.8	190.0	94.1	**86.5**	164.9	191.0	**88.7**	157.7	194.4	**56.9**
2008	**63.8**	**52.2**	**32.0**	180.6	177.6	**41.2**	**80.7**	99.2	109.1	**88.6**	**50.0**
2007	94.9	**88.5**	**44.9**	**51.8**	**78.5**	181.4	244.4	**76.9**	**76.6**	**63.5**	130.4
2006	127.9	95.3	**63.0**	**32.8**	**10.9**	**22.6**	**86.8**	117.5	109.1	100.1	67.1
2005	**76.4**	**44.9**	**75.4**	132.6	114.2	**33.1**	**59.8**	**83.0**	129.1	151.4	107.6
2004	262.4	172.0	191.6	119.9	**53.3**	117.1	170.1	187.2	131.5	84.1	**68.4**
Number of years indemnity could be paid	3	5	10	4	8	7	8	8	8	5	5

Source: USDA Risk Management Agency

Table 5: Values of the Rainfall Index for a Representative Grid (ID 26504) in Goshen County, Wyoming for each two-month insurance interval from 2004 to 2018

Year	Jan-Feb	Feb-Mar	Mar-Apr	Apr-May	May-Jun	Jun-Jul	Jul-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec
2018	**40.7**	117.1	85.6	152.0	139.7	103.7	104.0	**33.9**	**52.8**	**79.4**	**87.4**
2017	111.3	176.5	140.1	130.5	**81.3**	**50.1**	**85.7**	**85.0**	**78.5**	**74.8**	**67.3**
2016	**69.8**	199.2	200.1	131.7	**60.8**	**23.2**	**75.9**	107.6	**53.7**	**33.4**	**78.4**
2015	**37.9**	**27.4**	135.4	228.7	176.8	103.2	**80.7**	**24.3**	**68.3**	155.3	131.5
2014	130.9	146.5	94.7	138.2	134.0	88.0	138.2	224.8	133.9	82.6	159.6
2013	**54.7**	**44.8**	**54.5**	**66.7**	**66.0**	**52.2**	**53.1**	141.2	299.1	322.5	**69.6**
2012	103.4	**40.3**	**32.3**	**33.9**	**52.5**	**75.0**	**41.6**	**24.2**	**67.2**	**78.1**	**35.2**
2011	134.2	136.5	152.8	187.6	149.5	109.0	94.7	**30.7**	91.9	141.9	**69.4**
2010	124.8	179.5	168.0	142.3	165.1	141.2	**65.9**	**55.1**	**61.2**	116.6	166.3
2009	**81.0**	**79.5**	142.8	**86.4**	115.7	203.2	185.9	91.7	115.0	165.6	93.9
2008	**63.5**	**60.7**	**36.7**	**91.8**	101.0	**73.9**	149.4	208.0	110.1	64.7	56.3
2007	**74.8**	121.7	**98.7**	**70.6**	**40.6**	**69.6**	109.9	**56.3**	126.8	147.0	138.5
2006	**59.3**	131.6	**77.8**	**45.2**	**60.9**	**65.6**	**80.4**	**83.7**	**45.9**	**31.4**	**47.4**
2005	**46.0**	**32.6**	**70.1**	**84.6**	151.1	183.4	139.1	91.4	**88.6**	118.4	**27.5**
2004	**45.4**	**41.5**	**48.7**	**52.9**	**47.3**	94.7	113.4	146.6	221.6	173.3	**88.2**
Number of years indemnity could be paid	10	7	8	8	7	8	7	8	8	6	10

Source: USDA Risk Management Agency

There are three takeaways from the information reported in Tables 4 and 5.

- First, within a given period of years, the frequency of indemnity payments varies quite considerably among index intervals within any given grid.

- Second, for any given index interval, the frequency with which indemnities are made will vary among different grids. As discussed above and shown in Tables 4 and 5, land insured in the Fremont County grid in the January-February index interval would have received indemnity payments in three of the fifteen years. However, land insured in the Goshen County grid in the January-February index interval would have received indemnity payments in ten of those years.

- Third, although not immediately apparent from Tables 4 and 5, the average size of indemnity payments over a fifteen-year (or other) period will vary between index intervals for any given grid.

To illustrate the third takeaway, in Tables 6 and 7, indemnities are reported for each index interval in each year from 2004 to 2018 for the representative Fremont and Goshen County grids, assuming that a rancher's ***policy protection per unit*** in each index interval is $10,000 and the selected ***coverage level*** is 90%. Indemnities are calculated as described above by multiplying this amount of ***policy protection per unit*** by the applicable ***payment calculation factor***, defined above as the (***Trigger Grid Index - Final Grid Index)/Trigger Grid Index***.

The average indemnities for each index interval over the period 2004-2018 are also reported in Tables 6 and 7.

An ***indemnity*** is paid when the ***index value*** for the grid in a given two-month insurance interval is less than 90 when a ***coverage level*** of 90% is selected. The amount to be paid is equal to the amount of ***policy protection per unit*** ($10,000) multiplied by the ***payment factor*** = [(90 – Index Value)/90] if the index value is less than 90 and the producer is eligible for an indemnity. For example, in the Fremont County grid (Table 4) the 2018 March-April insurance period the value of the rainfall index was 79.8. Therefore, a rancher who had purchased insurance to cover $10,000 of ***policy protection*** for forage losses in that Fremont County grid would be eligible for an indemnity equal to $10,000 x (90 – 79.8)/90 = $10,000 x 0.1133 = $1,113, as shown in Table 6.

Table 6: Indemnities payable when a coverage level of 90% is selected by a producer in a Representative Grid (ID 27687) in Fremont County, Wyoming for each two-month insurance period on $10,000 of insured liability for forage in each insurance interval from 2004 to 2018

Year	Jan-Feb	Feb-Mar	Mar-Apr	Apr-May	May-Jun	Jun-Jul	Jul-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec
2018	$0	$0	$1,133	$0	$0	$22	$1,978	$8,056	$5,089	$0	$0
2017	$0	$0	$0	$0	$3,233	$6,333	$0	$0	$0	$0	$0
2016	$0	$0	$0	$0	$0	$7,122	$4,044	$0	$0	$0	$0
2015	$0	$0	$122	$0	$0	$0	$0	$8,511	$6,589	$0	$0
2014	$0	$0	$3,633	$5,556	$1,611	$0	$0	$0	$2,233	$4,100	$0
2013	$0	$133	$378	$0	$3,467	$7,000	$5,178	$0	$0	$0	$5,033
2012	$0	$1,767	$5,811	$3,767	$5,756	$9,089	$8,278	$8,600	$6,833	$3,344	$0
2011	$0	$0	$6,400	$0	$0	$5,433	$4,400	$3,778	$0	$0	$0
2010	$0	$0	$0	$0	$0	$0	$4,156	$6,800	$8,211	$5,756	$0
2009	$6,236	$0	$0	$0	$389	$0	$0	$144	$0	$0	$3,678
2008	$2,911	$4,200	$6,444	$0	$0	$5,422	$1,033	$0	$0	$156	$4,444
2007	$0	$167	$5,011	$4,244	$1,278	$0	$0	$1,456	$1,489	$2,944	$0
2006	$0	$0	$3,000	$6,356	$8,789	$7,489	$356	$0	$0	$0	$2,544
2005	$1,511	$5,011	$1,622	$0	$0	$6,322	$3,356	$778	$0	$0	$0
2004	$0	$0	$0	$0	$4,078	$0	$0	$0	$0	$656	$2,400
Average Indemnity (2004-2018)	**$711**	**$752**	**$2,237**	**$1,328**	**$1,907**	**$3,616**	**$2,185**	**$2,541**	**$2,030**	**$1,130**	**$1,207**

Source: The authors, based on the rainfall index data reported by USDA RMA presented in Table A1.

In the Fremont County representative grid, the average annual indemnity received by a rancher selecting 90% coverage for $10,000 of policy protection ranges from $711 in the January-February index interval to $3,616 in the June-July index interval.

In Fremont County precipitation critical to forage production tends to be concentrated in the April-May and July-August index intervals. Annual indemnities averaged $1,328 and $2,185 in the April-May and July-August index intervals for the representative Fremont County grid over the period 2004 to 2018 (Table 6).

Similarly, in the Goshen County grid for the 2018 January-February index interval the value of the rainfall index was 40.7, as shown in Table 5. Therefore, a producer who had purchased insurance to cover $10,000 of ***policy protection*** for forage losses would be eligible for an indemnity equal to: [$10,000 x (90 – 40.7)/90 = $10,000 x 0.5478] = $5,478, as shown in Table 7.

Table 7: Indemnities payable when a coverage level of 90% is selected by a producer in a Representative Grid (ID 26504) in Goshen County, Wyoming for each two-month insurance period on $10,000 of insured liability for forage in each insurance interval from 2004 to 2018*

Year	Jan-Feb	Feb-Mar	Mar-Apr	Apr-May	May-Jun	Jun-Jul	Jul-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec
2018	$5,478	$0	$489	$0	$0	$0	$0	$6,233	$4,133	$1,178	$289
2017	$0	$0	$0	$0	$967	$4,433	$478	$556	$1,278	$1,689	$2,522
2016	$2,244	$0	$0	$0	$3,244	$7,422	$1,567	$0	$4,033	$6,289	$1,289
2015	$5,789	$6,956	$0	$0	$0	$0	$1,033	$7,300	$2,411	$0	$0
2014	$0	$0	$0	$0	$0	$222	$0	$0	$0	$822	$0
2013	$3,922	$5,022	$3,944	$2,589	$2,667	$4,200	$4,100	$0	$0	$0	$2,267
2012	$0	$5,522	$6,411	$6,233	$4,167	$1,667	$5,378	$7,311	$2,533	$1,322	$6,089
2011	$0	$0	$0	$0	$0	$0	$0	$6,589	$0	$0	$2,289
2010	$0	$0	$0	$0	$0	$0	$2,678	$3,878	$3,200	$0	$0
2009	$1,000	$1,167	$0	$400	$0	$0	$0	$0	$0	$0	$0
2008	$2,944	$3,256	$5,922	$0	$0	$1,789	$0	$0	$0	$2,811	$3,744
2007	$1,689	$0	$0	$2,156	$5,489	$2,267	$0	$3,744	$0	$0	$0
2006	$3,411	$0	$1,356	$4,978	$3,233	$2,711	$1,067	$700	$4,900	$6,511	$4,733
2005	$4,889	$6,378	$2,211	$600	$0	$0	$0	$0	$156	$0	$6,944
2004	$4,956	$5,389	$4,589	$4,122	$4,744	-$522	$0	$0	$0	$0	$200
Average Indemnity (2004-2018)	**$2,421**	**$2,246**	**$1,661**	**$1,405**	**$1,634**	**$1,613**	**$1,087**	**$2,421**	**$1,510**	**$1,375**	**$2,024**

Source: The authors, based on the rainfall index data reported by USDA RMA presented in Table A1.

In the Goshen County representative grid, the average annual indemnity received by a rancher when selecting 90% coverage for $10,000 of policy protection ranges from $1,087 in the July-August index interval to $2,421in the January-February index interval.

In Goshen County rainfall critical to fall grazing tends to be concentrated in the April-May and July-August index intervals, the same critical periods for rainfall as in Fremont County. Annual indemnities in the selected Goshen County grid index averaged $1,405 and $1,087 in the April-May and July-August index intervals over the period 2004 to 2018 (Table 7).

It is important to note that when, on average, indemnities in an index interval are relatively low, on average rainfall in that interval is relatively high. Nevertheless, ranchers may choose to insure in such index intervals when the intervals represent periods in which adequate rainfall is critical to the forage production needed to sustain their livestock operations.

In assessing whether to adopt any risk management strategy, ranchers also consider the cost of that strategy to the ranch operation. Tables 8 and 9 show the total premiums, premium subsidies and premiums paid by producers for policy protection per unit in the amount of $10,000 for each ***index interval*** in the Fremont County and Goshen County representative grids. The premium costs reported in Tables 8 and 9 are computed using the RMA ***RI-PRF*** decision tool available to producers on the RMA website, assuming that insurance was obtained for the 2018 crop year.

Table 8: Average Indemnities and premiums payable in a Representative Grid (ID 27687) in Fremont County, Wyoming for each two-month insurance period on $10,000 of insured liability for forage in each insurance interval from 2004 to 2018.*

Interval	Jan-Feb	Feb-Mar	Mar-Apr	Apr-May	May-Jun	Jun-Jul	Jul-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec
Total premium	$2,413	$2,438	$2,110	$2,082	$1,983	$2,408	$2,164	$2,563	$2,641	$2,403	$2,359
Producer Subsidy	$1,231	$1,243	$1,076	$1,062	$1,011	$1,228	$1,104	$1,307	$1,347	$1,226	$1,203
Producer Paid Premium	$1,182	$1,195	$1,034	$1,020	$972	$1,180	$1,060	$1,256	$1,294	$1,177	$1,156
Average Indemnity	$711	$752	$2,237	$1,328	$1,907	$3,616	$2,185	$2,541	$2,030	$1,130	$1,207
Average Indemnity – Producer Paid Premium	**-$471**	**-$443**	**$1,203**	**$308**	**$935**	**$2,436**	**$1,125**	**$1,285**	**$736**	**-$47**	**$51**

*Premiums and premium subsidy estimates were obtained using the USDA RMA decision tool for the Pasture, Range and Forage policy, assuming that the producer purchased insurance for $10,000 of ***policy protection*** in 2018 for forage acres located in Grid ID 27687 in Fremont County, Wyoming.

In Fremont County, as shown in Table 8, total premiums for coverage for $10,000 of ***policy protection*** range from $1,983 in the May-June index interval to $2,641 in the September-October index interval, reflecting differences in the variability of precipitation in those index intervals. When ranchers obtain 90% coverage levels, the federal government pays 51% of their premiums. Thus, producer paid premiums range from $972 in the May-June index interval to $1,294 in the September-October index interval. As discussed above, and shown in Table 6, average indemnities over the period 2004 to 2018 vary substantially across the index intervals for this Fremont County grid.

Net indemnities, the difference between the average indemnity received over that period and the producer paid premium for each index interval, are shown in the last row of Table 8. These differences range from - $471 for the January-February index interval to $ 2,436 in the June-July index interval. Producer paid premiums exceed average indemnities over the period 2004-2018 in three index intervals (January-February, February-March, and October-November); average indemnities exceed producer paid premiums in the other nine index intervals.

A word of caution is important here. Premium rates are typically established using weather data over the period 1948 to the most recent year for which such data are available and are set with the goal of ensuring that total premiums cover indemnities. Producer paid premiums are substantially less than total premiums and not intended to cover total indemnities. *Given that only 15 years are used to calculate average indemnity payments for the Fremont County representative grid example, the results presented in Table 8 that show a negative difference between average indemnities received and premiums paid by ranchers should be viewed with caution.*

Table 9: Average Indemnities and premiums payable in a Representative Grid (ID 26504) in Goshen County, Wyoming for each two-month insurance period on $10,000 of insured liability for forage in each insurance interval from 2004 to 2018.*

Interval	Jan-Feb	Feb-Mar	Mar-Apr	Apr-May	May-Jun	Jun-Jul	Jul-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec
Total premium	$2,127	$2,379	$1,564	$1,548	$1,786	$1,429	$1,630	$2,000	$2,187	$2,117	$2,482
Producer Subsidy	$1,085	$1,213	$798	$789	$911	$729	$831	$1,020	$1,115	$1,080	$1,266
Producer Paid Premium	$1,042	$1,166	$766	$759	$875	$700	$799	$980	$1,072	$1,037	$1,216
Average Indemnity	$2,421	$2,246	$1,661	$1,405	$1,634	$1,613	$1,087	$2,421	$1,510	$1,375	$2,024
Average Indemnity – Producer Paid Premium	$1,379	$1,080	$895	$647	$759	$912	$288	$1,441	$438	$337	$808

*Premiums and premium subsidy estimates were obtained using the USDA RMA decision tool for the Pasture, Range and Forage policy, assuming that the producer purchased insurance for $10,000 of ***policy protection*** in 2018 for forage acres located in Grid ID 26504 in Goshen County, Wyoming.

A similar cautionary note applies to the results presented for the Goshen County representative grid in Table 9. In the Goshen County representative grid, total premiums for coverage for $10,000 of ***policy protection*** range from $1,429 in the June-July index interval to $2,482 in the November-December index interval, also reflecting differences in the variability of precipitation in those index intervals.

When ranchers obtain 90% coverage levels, the federal government pays 51% of their premiums. Thus, producer paid premiums range from $700 in the June-July index interval to $1,216 in the November-December index interval. As discussed above, and shown in Table 7, average indemnities over the period 2004 to 2018 also vary substantially across the index intervals for this Goshen County grid.

The differences between the average indemnity received over that period and the producer paid premium for each index interval are shown in the last row of Table 9. These differences range from $438 for the September-October index interval to $1,441 in the July-August index interval. In the representative Goshen County grid, average indemnities over the period 2004-2018 exceed the premiums that would have been paid by producers in 2018 in all eleven index intervals.

Finally, note that a rancher must pay a ***$30 administrative fee*** for any ***RI-PRF*** insurance, although, as with many federal crop insurance administrative fees, such fees may be waived for ***limited resource and socially disadvantaged producers***. Payments of such administrative fees are **not included** in Tables 8 and 9, which only considered premium payments.

Risk and Outcome Variability

The examples and analysis provided to this point suggest that ***RI-PRF*** insurance may be worthwhile looking into further. Although a great deal of information is available about each grid using the decision software on the USDA RMA website, it can be difficult to interpret. Even with all the data summarized in Tables 4-9, documenting what we might expect for example operations in two Wyoming counties, we might still ask "How often would we expect an ***RI-PRF*** policy to pay an indemnity?" Or, perhaps more importantly, "Given past experience, how much would we expect an ***RI-PRF*** indemnity payment to be and is the coverage it offers worth the cost?"

To answer the questions requires that we include risk in the analysis. The variability of greatest concern to us includes: 1. Variations in the ***final grid index*** values for the first ***grid*** selected and 2. Variations in the ***final grid index*** values for the second ***grid*** selected, as each of these might be expected to vary independently over time.

The Risk Scenario Planning (RSP) tool, developed by RightRisk (***RightRisk.org***), allows a rancher to apply partial budget analysis to decision making under uncertainty. The tool addresses the four traditional budgeting categories: added returns, added costs, reduced costs, and reduced returns.

Figure 1 shows the values from our example representative grid in Fremont County, Wyoming entered into the RSP tool interface. Line 1 in the Added Return section describes the $10,000 insurable value established using the RMA decision software on 1,277 acres. Lines 2-5 outline the coverage details for the April-May ***index interval***: the ***final grid index*** value, 90% coverage, 70% insurable value allocated to this interval, and the calculated ***indemnity payment*** where the ***final grid index*** falls below the ***trigger grid index.***
Lines 7-10 outline the coverage details for the July-August ***index interval***: the ***final grid index*** value, 90% coverage, 30% insurable value allocated to this interval, and the calculated ***indemnity payment*** where the ***final grid index*** falls below the ***trigger grid index.***

Figure 1. Completed Partial Budget Analysis for a Representative Grid (ID 27687) in Fremont County, Wyoming

RightRisk™ — *Partial Budget For:* *RI-PRF Coverage for Grid ID 27687 in Fremont County, Wyoming*

Positive Effects				*Negative Effects*			
Added Returns	**Quantity**	**Value**	**Total**	**Added Costs**	**Quantity**	**Value**	
Grid ID: #27687 insurable value		$ 10,000.00	$ -	*RI-PRF policy premium (per acre)*	1277	$ 0.81	$ 1,032.00
April-May interval: index value	100		$ -				$ -
April-May interval: coverage level (%)	90		$ -				$ -
April-May interval: percent of value (%)	70		$ -				$ -
April-May interval: indemnity payment	0	$ 10,000.00	$ -				$ -
			$ -				$ -
July-August interval: index value	100		$ -				$ -
July-August interval: coverage level (%)	90		$ -				$ -
July-August interval: percent of value (%)	30		$ -				$ -
July-August interval: indemnity payment	0	$ 10,000.00	$ -				$ -
			$ -				$ -
Total Added Returns			$ -	**Total Added Costs**			$ 1,032.00
Reduced Costs	**Quantity**	**Value**		**Reduced Returns**	**Quantity**	**Value**	
			$ -				$ -
			$ -				$ -
			$ -				$ -
			$ -				$ -
Total Reduced Costs			$ -	**Total Reduced Returns**			$ -

Total Positive Effects (Added Returns + Reduced Costs)	$ -	**Total Negative Effects** (Added Costs + Reduced Returns)	$ 1,032.00

Net Benefit of: RI-PRF Coverage for Grid ID 27687 in Fremont County, Wyoming	$ (1,032.00)

Figure 2. Sample Risk Scenario for the April-May and July-August RI-PRF Index Intervals in a Representative Grid (ID 27687) in Fremont County, Wyoming

Risk Scenarios					
Uncertain Value 1		☑ Include	Uncertain Value 2		☑ Include
Description	Cell		Description	Cell	
April-May index value	C7		*July-August index value*	C12	
Current Value (Most Likely)	100		Current Value (Most Likely)	100	
Minimum Value	32.8		Minimum Value	15.5	
Maximum Value	220.8		Maximum Value	244.4	

On the negative side of the ledger, line 1 in the Added Cost section describes the added cost of the RI-PRF policy premium per acre, totaling $1,032 for the annual ***producer premium per unit***.

The calculated net benefit totals -$1,032 with the ***final grid index*** set at 100 for the two ***index intervals*** and the ***total premium*** set at $1,032. Ranchers purchase RI-PRF insurance for the protection it provides against losses of hay and forage production caused by inadequate precipitation.

The RSP tool allows for uncertainty to be incorporated into any two cells in the scenario (Figure 2). Here Uncertain value 1 is the ***final grid index*** value entered in cell C7 for the April-May ***index interval***. The currently expected ***final grid index*** is set at 100 (Figure 1) is entered as the current/most likely value for this variable.

Looking back at the RMA **Rainfall Index** values reported for the April-May interval from 2004-2018 (Table 4), we see values ranging from 32.8, entered as a possible minimum value, and 220.8 entered as a possible maximum value (Figure 2).

These risk scenario values are used to create a beta distribution of possible ***final grid index*** values.

Uncertain value 2 is the ***final grid index*** value entered in cell C12 for the July-August ***index interval***. The currently expected ***final grid index*** is set at 100 (Figure 1) is entered as the current/most likely value for this variable.

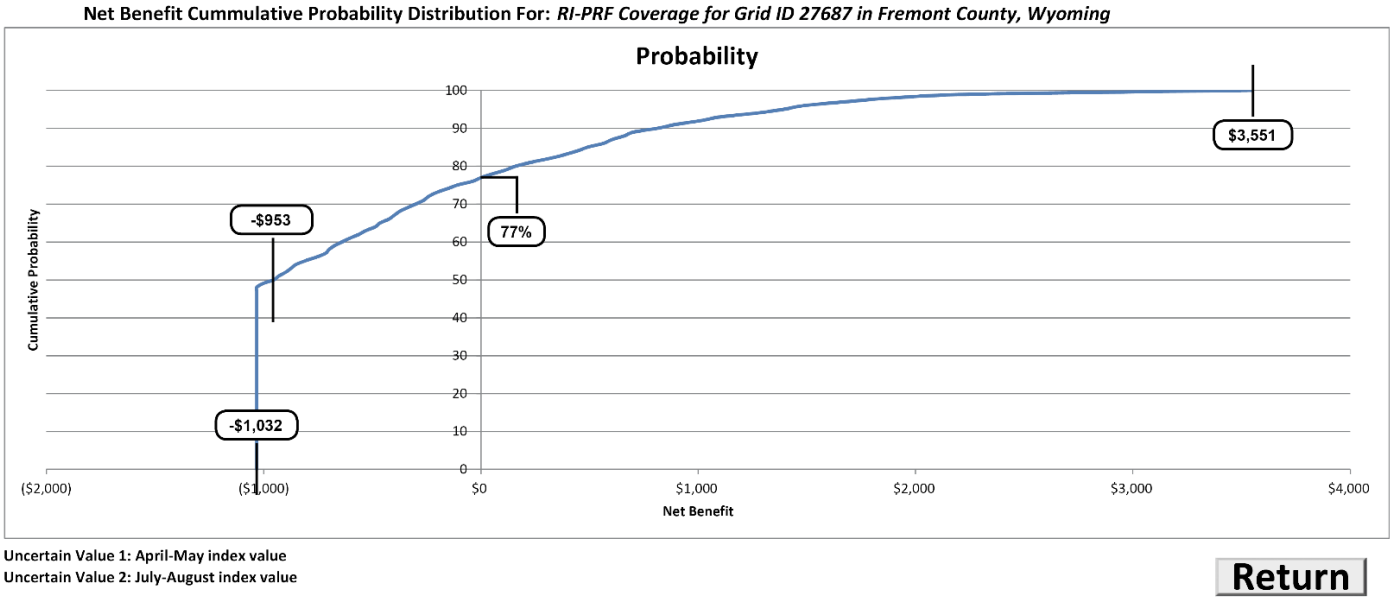
Again, looking at the RMA **Rainfall Index** values reported for the July-August interval from 2004-2018 (Table 4), we see values ranging from 15.5, entered as a possible minimum value, and 244.4 entered as a possible maximum value (Figure 2). Figure 3 shows the result of allowing the ***final grid index*** values for the two ***index intervals*** to vary from the expected value of 100. The net return at any combination of ***final grid index*** values is easily calculated. What is not so easy is assigning a probability to each of those net returns.

When the user clicks the "Run" button, the RSP tool performs an analysis based on the specified risk scenario (1,000 iterations). The results are depicted as a cumulative distribution graph (Figure 3). In this graph, we can see that the net return values range from a possible low of -$1,032 to a high of $3,551. In addition, we can see there is a 50/50 probability the value will fall around -$953.

Within the RSP tool, the user is allowed to mouse over points on the graph to read the probabilities for earning individual returns. In this way, the graph describes the range of possibilities, as well as the probability of achieving a particular threshold of net revenue.

Reading the probabilities from points along the curve in Figure 3, we can see that the analysis shows we could expect the ***RI-PRF*** coverage for the selected ***index intervals*** to offer a positive ***indemnity payment*** around 23% of the time or roughly 1 out every 4 years.

Figure 3. Distribution of Results Estimated by Allowing the Final Grid Index to vary for the April-May and July-August RI-PRF Index Intervals in a Representative Grid (ID 27687) in Fremont County, Wyoming



From another perspective, the ***RI-PRF*** policy could be expected to pay an ***indemnity payment*** over and above the cost of the ***producer premium*** about 52 percent of the time, softening the blow of reduced forage due to covered losses.

Other ***coverage levels*** for other ***index intervals*** available in ***grid*** ID 27687 may yield differing results; further RSP analysis may help to better identify intervals of greater risk for forage loss, higher payments, or better protection.

Let's now consider the representative grid for Goshen County, Wyoming. Figure 4 shows the values from our example representative grid in Goshen County entered into the RSP tool interface. Line 1 in the Added Return section describes the $10,000 insurable value established using the RMA decision software on 1,339 acres. Lines 2-5 outline the coverage details for the April-May ***index interval***: the ***final grid index*** value, 90% coverage, 70% insurable value allocated to this interval, and the calculated ***indemnity payment*** where the ***final grid index*** falls below the ***trigger grid index.*** Lines 7-10 outline the coverage details for the July-August ***index interval***: the ***final grid index*** value, 90% coverage, 30% insurable value allocated to this interval, and the calculated ***indemnity payment*** where the ***final grid index*** falls below the ***trigger grid index.***

On the negative side of the ledger, line 1 in the Added Cost section describes the added cost of the RI-PRF policy premium per acre, totaling $771 for the annual ***producer premium per unit***.

The calculated net benefit totals -$771 with the ***final grid index*** set at 100 for the two ***index intervals*** and the ***total premium*** set at $771.

Looking back at the RMA **Rainfall Index** values reported for the April-May interval from 2004-2018 (Table 5), we see values ranging from 33.9, entered as a possible minimum value, and 228.7 entered as a possible maximum value (Figure 5).

Uncertain value 2 is the ***final grid index*** value entered in cell C12 for the July-August ***index interval***. The currently expected ***final grid index*** is set at 100 (Figure 4) is entered as the current/most likely value for this variable.

Again, looking at the RMA **Rainfall Index** values reported for the July-August interval from 2004-2018 (Table 5), we see values ranging from 41.6, entered as a possible minimum value, and 185.9 entered as a possible maximum value (Figure 5).

Figure 4. Completed Partial Budget Analysis for a Representative Grid (ID 26504) in Goshen County, Wyoming

RightRisk™ — Partial Budget For: RI-PRF Coverage for Grid ID 26504 in Goshen County, Wyoming

Positive Effects				Negative Effects			
Added Returns	**Quantity**	**Value**	**Total**	**Added Costs**	**Quantity**	**Value**	
Grid ID: #26504 insurable value		$ 10,000.00	$ -	RI-PRF policy premium (per acre)	1339	$ 0.58	$ 771.00
April-May interval: index value	100		$ -				$ -
April-May interval: coverage level (%)	90		$ -				$ -
April-May interval: percent of value (%)	70		$ -				$ -
April-May interval: indemnity payment	0	$ 10,000.00	$ -				$ -
			$ -				$ -
July-August interval: index value	100		$ -				$ -
July-August interval: coverage level (%)	90		$ -				$ -
July-August interval: percent of value (%)	30		$ -				$ -
July-August interval: indemnity payment	0	$ 10,000.00	$ -				$ -
			$ -				$ -
Total Added Returns			$ -	**Total Added Costs**			$ 771.00
Reduced Costs	**Quantity**	**Value**		**Reduced Returns**	**Quantity**	**Value**	
			$ -				$ -
			$ -				$ -
			$ -				$ -
			$ -				$ -
Total Reduced Costs			$ -	**Total Reduced Returns**			$ -

Total Positive Effects (Added Returns + Reduced Costs)	$ -	**Total Negative Effects** (Added Costs + Reduced Returns)	$ 771.00

Net Benefit of: RI-PRF Coverage for Grid ID 26504 in Goshen County, Wyoming	$ (771.00)

Figure 5. Sample Risk Scenario for the April-May and July-August RI-PRF Index Intervals in a Representative Grid (ID 26504) in Goshen County, Wyoming

Risk Scenarios

Uncertain Value 1 ☑ Include		Uncertain Value 2 ☑ Include	
Description	**Cell**	**Description**	**Cell**
April-May index value	C7	July-August index value	C12
Current Value (Most Likely)	100	Current Value (Most Likely)	100
Minimum Value	33.9	Minimum Value	41.6
Maximum Value	228.7	Maximum Value	185.9

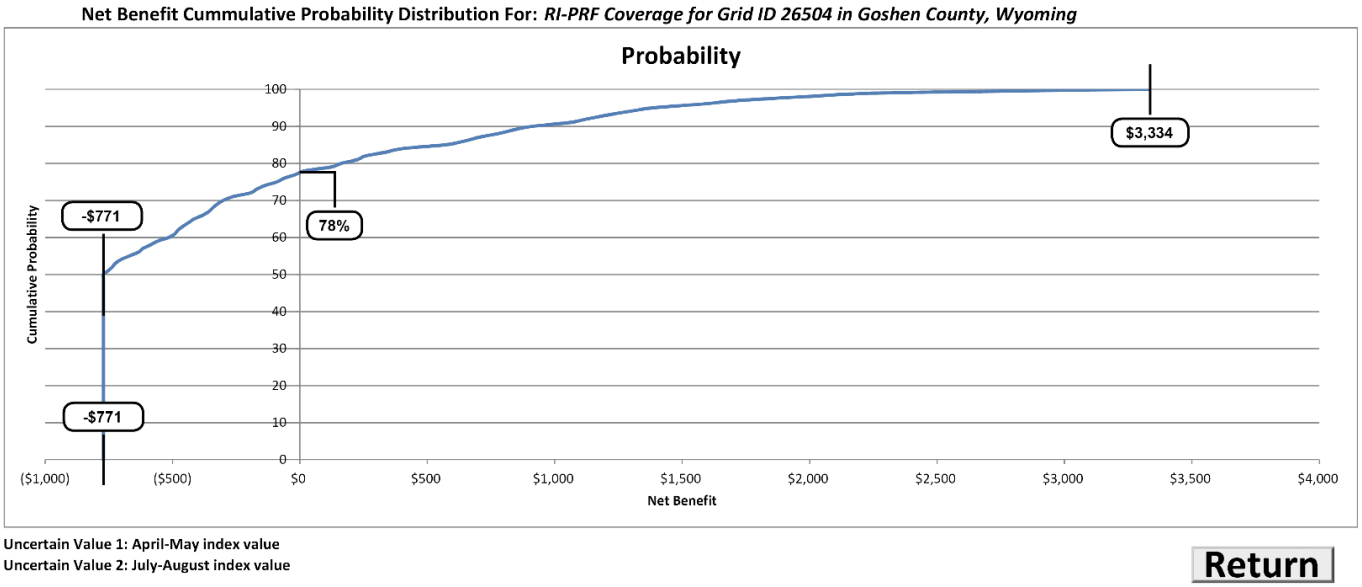
Figure 6 shows the result of allowing the ***final grid index*** values for the two ***index intervals*** to vary from the expected value of 100. The net return at any combination of ***final grid index*** values is easily calculated. What is not so easy is assigning a probability to each of those net returns.

When the user clicks the "Run" button, the RSP tool performs an analysis based on the specified risk scenario (1,000 iterations). The results are depicted as a cumulative distribution graph (Figure 6). In this graph, we can see that the net return values range from a possible low of -$771 to a high of $3,334. In addition, we can see there is a 50/50 probability the value will fall around -$771.

Within the RSP tool, the user is allowed to mouse over points on the graph to read the probabilities for earning individual returns. In this way, the graph describes the range of possibilities, as well as the probability of achieving a particular threshold of net revenue.

Reading the probabilities from points along the curve in Figure 6, we can see that the analysis shows we could expect the ***RI-PRF*** coverage for the selected ***index intervals*** to offer a positive ***indemnity payment*** around 22% of the time or roughly 1 out every 5 years.

Figure 6. Distribution of Results Estimated by Allowing the Final Grid Index to vary for the April-May and July-August RI-PRF Index Intervals in a Representative Grid (ID 26504) in Goshen County, Wyoming



From another perspective, the ***RI-PRF*** policy could be expected to pay an ***indemnity payment*** over and above the cost of the ***producer premium*** about 50 percent of the time, softening the blow of reduced forage due to covered losses.

Other ***coverage levels*** for other ***index intervals*** available in ***grid*** ID 262504 may yield differing results; further RSP analysis may help to better identify intervals of greater risk for forage loss, higher payments, or better protection.

Summary

Pasture Range Forage Rainfall Index Insurance coverage is now available in all eleven Western States. Increasingly, ranchers have utilized the insurance product in their forage production risk management strategies in those states and between 2016 and 2018, ranchers in those states tripled the amount of ***RI-PRF*** insurance they obtained. The purpose of the product is to enable ranch operations to obtain financial resources through indemnity payments when critical shortfalls in forage production occur on grazingland and hayland because of lack of adequate precipitation. As with other ***RMA*** insurance products, ***RI-PRF*** premiums paid by farmers are subsidized by the federal government.

When a rancher obtains ***RI-PRF*** insurance coverage, the rancher receives an indemnity when, in the area in which the land on which forage is produced is located, the rainfall index for that area falls sufficiently below its expected level during the two month periods of the year, called ***index intervals***, for which coverage has been purchased.

The area with which the indexes are associated is called a ***grid***, and the values of the rainfall indexes for each grid are constructed and reported by the ***National Oceanographic and Atmospheric Administration*** using data collected on a daily basis from over 6,000 weather stations.

Each year includes eleven two-month index intervals, and in insuring against loss of forage a rancher must select at least two different index intervals. A minimum of 10% of the acreage the rancher insures must be included in any index interval, but no more than 70% of the acreage to be insured can be included in any index interval. Ranchers are encouraged to carefully evaluate which index intervals should be used to optimize their risk management strategies. The USDA Risk Management Agency has a decision tool that provides detailed information about the history of index values for each index interval in each grid. Ranchers are encouraged to use the decision tool

to help them make their ***RI-PRF insurance*** decisions.

Finally, ranchers should be aware that grid rainfall indexes do not measure rainfall on their own land, but are intended to represent precipitation throughout the grid. Thus, a rancher may experience shortfalls in precipitation and substantial reductions in forage production on their grazingland and hayland but not receive an indemnity payment because the rainfall index for the grid is not sufficiently low to trigger an indemnity payment.

Appendix

Table A1: Liability, Premium, and Indemnity Information for PRF-Rainfall Index Insurance in each of the Western United States, 2016

State	Liability ($ million)	Total Premium ($ million)	Subsidy ($ million)	Producer Premiums ($ million)	Indemnity ($ million)	Indemnity /Total Premium	Indemnity /Producer Premium
Arizona	16.9	4.5	2.5	2.0	3.7	0.81	1.77
California	52.8	14.9	8.1	6.7	6.9	0.46	1.02
Colorado	86.5	17.5	9.2	8.3	18.6	1.06	2.24
Idaho	1.9	0.5	0.2	0.2	0.6	1.21	2.52
Montana	30.7	5.2	2.8	2.5	2.5	0.47	1.01
Nevada	24.5	6.2	3.6	2.6	8.2	1.20	3.14
New Mexico	51.2	12.8	7.0	5.7	8.5	0.67	1.49
Oregon	13.3	2.8	1.5	1.3	2.5	0.86	1.89
Utah	6.3	1.2	0.7	0.6	0.9	0.75	1.62
Washington	3.7	0.8	0.4	0.4	0.8	0.96	0.96
Wyoming	27.3	4.5	2.4	2.2	4.8	1.06	2.19
Total	315.0	71.0	38.5	32.5	57.8	0.81	1.78

Table A2: Liability, Premium, and Indemnity Information of PRF-Rainfall Index Insurance in each of the Western United States, 2017

State	Liability ($ million)	Total Premium ($ million)	Subsidy ($ million)	Producer Premiums ($ million)	Indemnity ($ million)	Indemnity /Total Premium	Indemnity /Producer Premium
Arizona	270.3	80.0	42.3	37.7	93.7	1.17	2.48
California	57.6	15.9	8.7	7.1	15.6	0.98	2.19
Colorado	140.7	34.9	18.1	16.8	3.8	1.10	2.29
Idaho	3.5	0.9	0.5	0.4	0.3	0.40	0.85
Montana	23.2	4.0	2.1	1.9	6.1	1.53	3.41
Nevada	23.9	6.7	3.6	3.1	2.8	0.42	0.89
New Mexico	95.0	24.8	13.6	11.2	18.7	0.76	1.67
Oregon	19.7	4.5	2.5	2.0	3.7	0.83	1.82
Utah	7.2	1.6	0.8	0.7	1.8	1.17	2.54
Washington	10.5	2.6	1.3	1.3	3.8	1.47	3.02
Wyoming	29.3	4.5	2.4	2.2	4.7	1.06	2.20
Total	681.1	180.4	95.9	84.5	190.0	1.05	2.25

Table A3: Liability, Premium, and Indemnity Information for PRF-Rainfall Index Insurance in each of the Western United States, 2018

State	Liability ($ million)	Total Premium ($ million)	Subsidy ($ million)	Producer Premiums ($ million)	Indemnity ($ million)	Indemnity /Total Premium	Indemnity /Producer Premium
Arizona	388.2	112.8	59.9	52.9	111.2	0.99	2.10
California	64.3	17.9	9.9	8.7	20.0	1.11	2.48
Colorado	95.6	21.9	11.2	10. 2	30.3	1.41	2.95
Idaho	12.1	2.6	1.4	1. 2	4.3	1.61	3.47
Montana	33.0	5.6	3.0	2.6	3.7	0.67	1.43
Nevada	93.9	24.8	13.5	11.3	31.5	1.27	2.78
New Mexico	121.8	31.4	17.4	14.12	33.3	1.06	2.36
Oregon	40.5	9.2	5.0	4,2	15.2	1.65	3.64
Utah	46.6	10.9	5.8	5.1	12.0	1.10	2.35
Washington	12.7	3.2	1.6	1.6	6.6	2.03	4.18
Wyoming	52.5	9.7	5.1	4.6	7.2	0.74	1.55
Total	966.0	249.9	134.0	115.9	275.3	1.10	2.37