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Grain Contracting Strategies: The Case of Durum Wheat

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Abstract:

One of the impacts of higher prices along with greater volatility in futures, basis and spreads is that there is pressure for greater use of cash contracts for grain. There is a wide array of cash contracts with varying terms that pose major strategic alternatives for buyers and the marketing system, particularly as buyers seek to use contracting as an element of risk mitigation. Durum is a crop where many of these issues and challenges are apparent. Durum is more risky than competing crops with greater price, yield and quality risk. And in contrast to competing crops, futures do not exist, cross hedging is poor and forward contracting has been used minimally.

There are three purposes of this article: Provide a survey of contract terms used in grain contracting with growers, illustrate some issues in contracting of some of the specialty grains (durum) in the upper Midwest, and develop a model to analyze alternative contracting strategies in the case of durum. We introduce alternative pricing features, and explore other alternatives and analyze them in terms of risk and return to growers.

Grain Contracting Strategies: The Case of Durum Wheat[1]

Introduction

Markets for many components of grain prices have become more volatile in recent years. As a result of these and other reasons, there has been an escalation in contracting which involves risk sharing between buyers and sellers. This differs from hedging in futures markets in which risk is transferred to an anonymous third party. One of the challenges in contracting is determining the appropriate risk premium accrued by participants, and how that is shared between the buyer and seller. The other source of risk is contract non-performance or delivery (breach), which has evolved as a major problem for buyers and the marketing system, particularly as buyers seek to use contracting as an element of risk mitigation.

Contracting is compounded by a number of factors. One is the competition for acres (or, commonly, the *battle for acres*). The impact of this is for an escalation in the use of pre-plant contracts, and use of contract terms that impact inter-crop and inter-firm competition. Second is that while standard terms exist in commodity type grain contracts, contracting in this competitive environment has resulted in challenges structuring contracts to be incentive compatible. Third, if a contract is offered by a buyer, it is done so in part as a means of risk mitigation by buyer (and seller). Consequently, if one party breaches, it abrogates the risk mitigation strategy of the counter party. Finally, and importantly, all buyers confront the business relationship challenge of whether to initiate legal proceedings against farmers or suppliers who knowingly breach their contract. While there are differing views on this, it remains an outstanding strategic issue.[2]

Durum is a crop where many of these issues and challenges are applicable. Durum is more risky than competing crops. There is greater price and yield risk as well as quality risk. And in contrast to competing crops, futures do not exist, cross hedging is poor and forward contracting has been used minimally.

The purpose of this paper is to analyze problems of contract alternatives and some of the issues confronting the grain industry related to contracting. There are three specific purposes. First, we provide a broad survey of contract terms used in grain contracting with growers. Second, we illustrate some issues in contracting of some of the specialty grains (durum) in the upper Midwest. Finally, we develop a model to analyze alternative contracting strategies in the case of durum wheat. In this, we introduce alternative pricing features, as well as explore other alternatives and analyze them in terms of risk and return to growers.

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[1] This is a comprehensive research report and shows relevant background data, analytical tools and derivations. A summary of this report is available entitled AAER???-S *Grain Contracting Strategies: The Case of Durum Wheat* and is available at http://ageconsearch.umn.edu/.

[2] See Wilson and Dahl (2010) for a detailed discussion.

The paper is organized as follows. First we describe volatility and risk and why this provides a motive for the escalation in contracting. Then we discuss what we observe as growth in contracting for grains. This includes a description of contract terms and contract competition. We illustrate some of the challenges, in this case as applied to contracting for durum wheat. Specifically, we develop a model to analyze risks and returns for alternative durum contracting strategies. These are used to determine risk premiums for growers in order to induce them to choose durum versus competing crops, in this case HRS wheat.

Volatility

It is now common knowledge that there has been an escalation in volatility in recent years. While there may be debate about why or whether it will continue, all market participants acknowledge that the escalation in volatility has increased risk in grain marketing.

There are several points that are perhaps less recognized. First, not only has there been an escalation in volatility in the underlying futures markets, but there has been an increase in volatility in several other elements of prices. For example, the basis in many markets has increased similarly (Figure 1, as an example). In fact, for wheat traded at the Minneapolis Grain Exchange (MGEX), the basis volatility has increased sharply, and in some periods, it has been more volatile than the underlying futures market price. Taken together, this has reduced the hedging effectiveness of the instrument (though it remains better than alternatives) and severely altered optimal hedge ratios. Similar observations exist at many other basis markets. There has also been a radical change in volatility in premiums/discounts in grains, as well as in shipping costs, notably ocean rates, amongst rates for other modes. Durum prices at Minneapolis and the spread between durum and MGEX futures show increased volatility from 2007 forward (Figures 2 and 3). All of these have implications for buyers.

Given that these underlying fundamentals are expected to persist in future years, it is expected that volatility will remain higher than in earlier years, albeit less than observed in 2008. More likely, this will persist for 4-8 years until new crop production technologies are adopted and ultimately improve the dynamics of the supply/demand balance. Nevertheless, a primary reason buyers and sellers have been seeking, or exploring, alternative contracting strategies is due in part to the reduced ability of traditional mechanisms for controlling risks (notably futures which are more volatile, and options which, as a result of the greater volatility results in higher premiums).

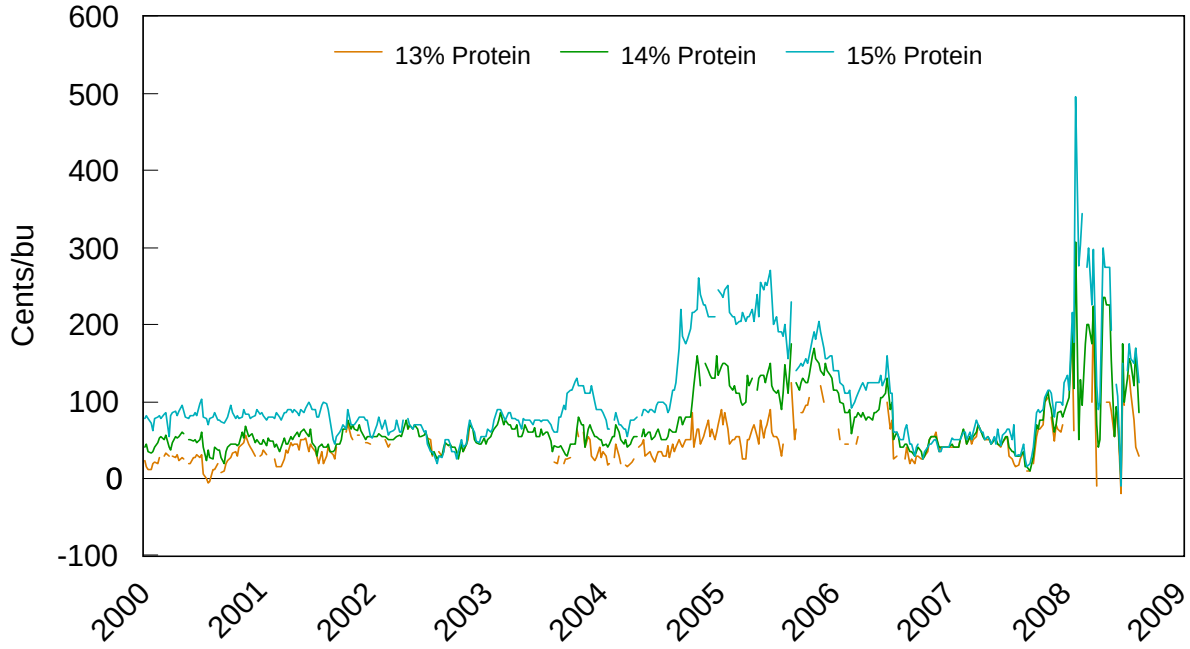

Figure 1. Minneapolis Cash Basis Over MGEX Futures for Hard Red Spring Wheat by Protein Level.

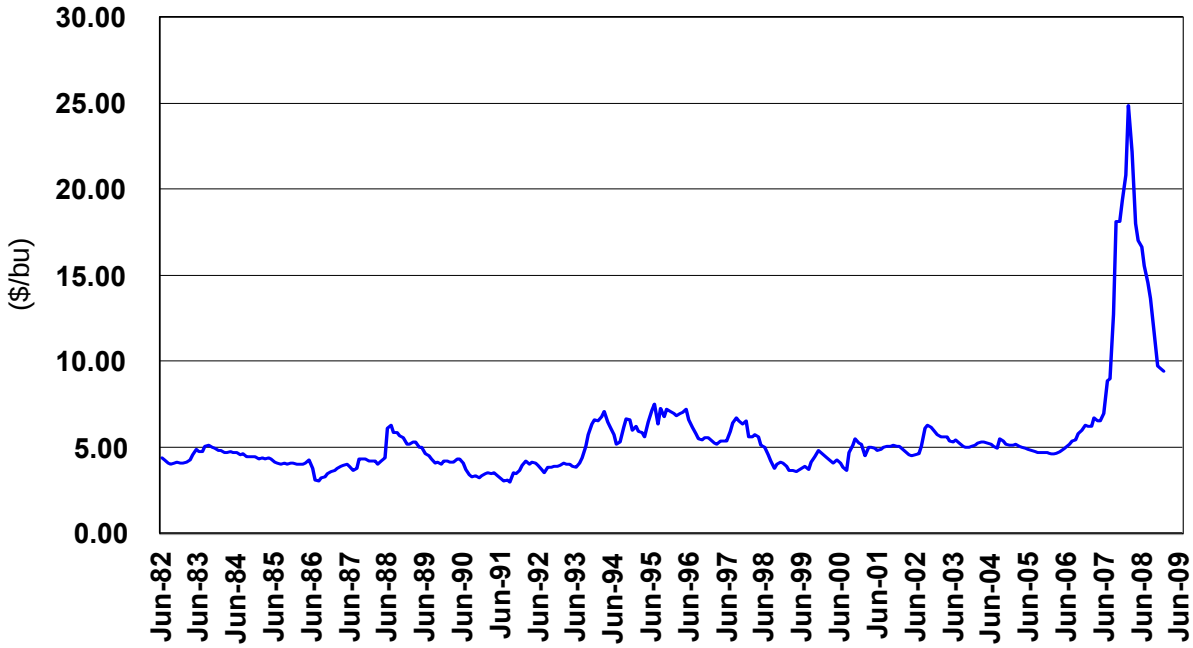

Figure 2. Monthly Minneapolis Hard Amber Durum Prices, June 1982-February 2009.

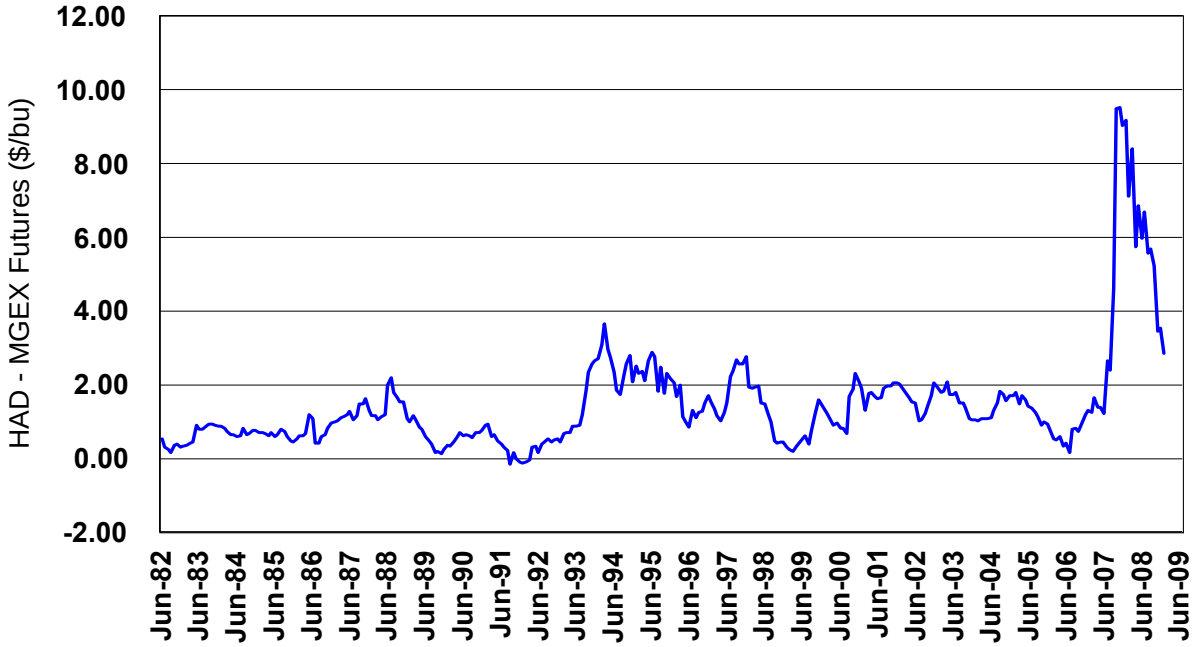

Figure 3. Monthly Spread Between Minneapolis Hard Amber Durum Prices and MGEX, HRS Futures, June 1982 to February 2009.

Contracting for Grains

We discuss three topics related to contracting for grains. One describes the factors contributing to the apparent growth in contracting. Second, we discuss the battle for acres in particular, and the implications for contracting. And, third, we present a summary of some of the major clauses contained in grain contracts in the new emerging contracting competition.

Growth in Contracting

The most recent broad based survey on contracting in agriculture (to our knowledge) was done by MacDonald et al., (2004) who examined contracting of commodities in the U.S. in 2001 and compared use of contracts to that in various time periods. They indicate that the number of farms using contracts and value of production under contract increased from 1969 to 2001. The number of farms using contracts increased from 6% to 11% from 1969 to 2001 and the value of production increased from 12% in 1969 to 36% in 2001. They illustrate that the share of wheat under contract increased from 6% of value in 1991-1993 to a high of 9% in 1996-1997 and declined to 5% in 2001. Most of the contracting of crops was focused in fruit, vegetables, rice, sugar beets, and peanuts. Contracts in crops were largely marketing contracts, while livestock contained both marketing and production contracts.

MacDonald et al., (2004) conclude that the spot market is having difficulty providing accurate price signals for products geared toward new consumer demands. They indicate that this trend for increased use of vertical coordination, through contracts and ownership will continue.

More recently, it is our observation that contracting has escalated drastically. While it is difficult to document this without a broad-based survey, it is our observation that for some commodities pre-plant contracting has been adopted for more than 70% of industry demand, and has now become common business practice in the industry. We would attribute that this is in response to three important factors. One is the battle for acres. The second is the apparent escalation in risk, as a result of the increase in volatility as described above. Third is the apparent deterioration of, or unavailability of, traditional hedging mechanisms for managing risks (Wilson and Dahl, forthcoming).

Competition and the Battle for Acres: Implications for Contracting

In part due to the growth in demands relative to supplies and shifts in agronomic technology and production practices, a battle for acres exists in some regions of United States agriculture. While in some states there are few cropping opportunities and the battle is not as apparent, in North Dakota, as an example, growers in many regions have up to 12-18 different crops that can be grown. In fact, extension budgets normally contain returns for this many crops (Swenson *et al*). Some elevators now post prices for up to 12 crops at one time. Finally, it should be noted, that in this state the crops are apparently as diverse as any other state with the exception of California.

As a result of this, and the growth in GM row crops in non-traditional regions, there has been a shift in production. The response has been for an escalation in contracting. As examples, canola contracts have been offered with Act-of-God (AOG)clauses for prescribed varieties, and some of the ethanol plants offered contracts for 3 years production. Most of the malting barley is now bought on pre-planting contracts (Wilson, Gustafson and Dahl). Some of these are one year contracts with an option on the 2nd year, which are offered up to 14 months prior to harvest and there have been relaxed quality requirements. Most of the different types of sunflowers have extensive contracting mechanisms. There has been lesser contracting in durum wheat, but pre-planting contracts were offered during 2007 for new crop (pre-planting) delivery and during the 2008 contracting season, contracts were offered with a record premium relative to HRS wheat. And, many of the minor crops, including peas, edible beans, Sunflower, NuSun, Vestive, etc. are all nearly 100% contracted.

Contract Terms

A contract is a mechanism of risk sharing. Risks are pervasive including risks on price, quality, quantity, acceptance rates, etc. Hedging in futures contracts provide a mechanism to share an element of “price” risk which is transferred to a 3rd party. Thus,

many contracts allow pricing relative to a "futures" price, essentially to allow for 3rd party risk transfer. Absent of futures component of pricing, risk is strictly shared between buyer and seller.

The Figure below (Figure 4) is used to characterize the types of contracting now used, as an alternative for procurement strategy (adapted from Wilson and Dahl, 2008). This highlights differences that may be embedded in different contract types. It illustrates the range of alternatives, from relying on simple spot transactions, to include varying types of contracting, and finally, the alternative is always that of vertical integration. Ultimately, it is the buyer that chooses where to be strategically positioned on this spectrum of alternatives.

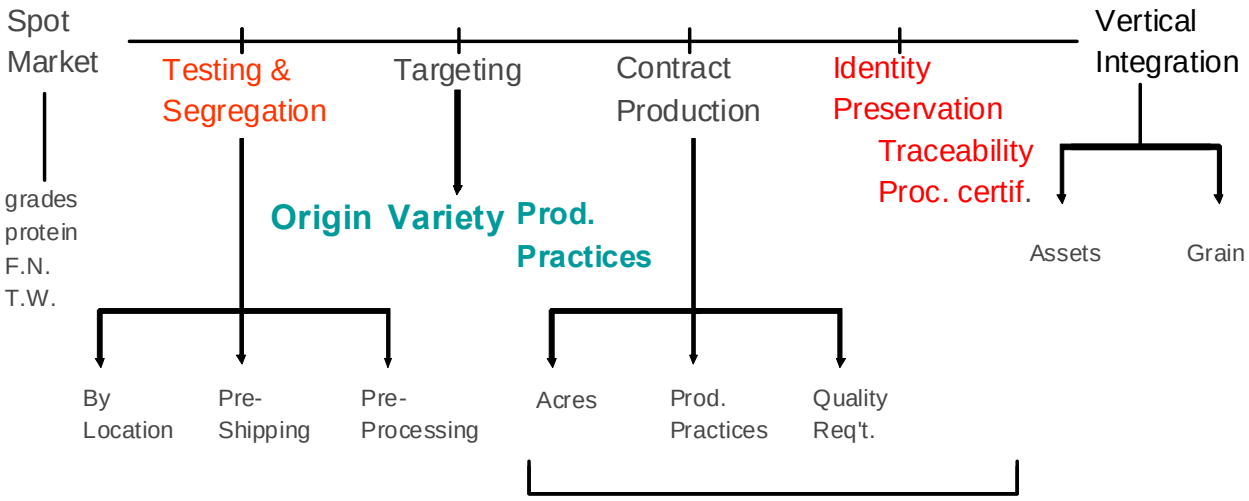

Figure 4. Segregation, IP and Traceability: Spectrum of Procurement Strategies.

To understand the scope and extent of contracting currently used in the upper Midwest, we surveyed a group of buyers and processors of some of the non-commodity type grains produced. These would be considered as marketing contracts, as opposed to production contracts (Michigan Farm Bureau, 2009) and these should not be considered as specialty crops since at least in the past they had been considered as commodities. These are represented as crops which are not as readily tradable as the major commodities such as corn, soybeans and winter wheat.

The major contract terms are categorized and summarized below.[3]

[3] For obvious reasons it is not possible to disclose the firm names etc, but that is not important for purposes here.

Act-of-God

Most of the contracts, though not all, contain Act-of-God (AOG) provisions. Sometimes these clauses are offered without a price differential. Specific examples are shown in Table 1 below.

AOG provisions are common across crops but, they are by no means standardized. There are many different interpretations of AOG clauses. Those most common are 1) a limit on the proportion of normal production or maximum contracted volume that can be covered under AOG; 2) a price differential for AOG provisions; 3) information requirements in order to verify yield losses which can include description of location of field and/or crop insurance adjustment assessments; and 4) limitations on specific location to apply for contract (requirement that contract applies only to crop produced on specific field identified in the contract). Specific crops may require specific varieties for contracts, these include among others, malting barley and high oleic sunflowers and canola. AOG provisions may also involve the first right of refusal on purchase of any volume exceeding the contracted volume.

Table 1. Selected Characteristics of Example AOG Contract Provisions by Crop

Crop	*Discount for AOG*	*Max Contract Allowed*	*AOG Requirements*	*Variety Requirements*	*Source*
Durum	Limited obs of $1.00/bu	Unknown			SunPrairie Dakota Growers Pasta
Barley		50 bu/a		Variety Specific	Anheuser Busch
Flax	$0.50/bu	15 bu/a	Crop Insurance Adjustment Information Required to release		SunPrairie
NuSun Sunflowers	$1.00/cwt	1000-1200 lbs/a dependent on county			SunPrairie
High Oleic Sunflowers		2000 lbs/a		Variety Specific	SunPrairie
Canola	$0.50 - $1.00/cwt	1000 lbs/a			SunPrairie
High Oleic Canola	$0.45/cwt	1000 lbs/a		Variety Specific	SunPrairie

Pates indicates that for high oleic sunflowers, for 2009 Technology Crops International Inc. is offering contracts with a premium of $3/cwt over NuSun prices or growers would be allowed to price up to 25% of the crop on the Chicago Soybean futures with the remainder at $2/cwt over NuSun prices (Pates, 2009).

Pricing Alternatives and Provisions

Overview: There are many types of pricing mechanisms. These include, as examples: Simple fixed price; Basis to single futures or multiple futures; 2-part pricing (base quantity at contract price; Surplus at discount (reflecting implicit storage costs); and in a number of contracts there are option type features (implicit) including Minimum price and in some cases Min/max, Lookback options, and Average prices guaranteed (equivalent to an Asian option). While several of these are option based contracts, our observation is that in practice, these pricing provisions do not include a price differential to a fixed price contract and hence the buyer is absorbing the implicit cost of the option. Typically growers have the option to time the pricing decision.

A set of contracts are proposed in the empirical analysis that would give growers choices, and provide mechanisms to limit the exposure to price risk for the buyer. These include Fixed price, Spread (or basis) to MGEX futures, Minimum priced with different floors and a Minimum/Maximum price contract. Details of these are described below. These are motivated in part due to what appears to be evolutionary pressures. A fixed price contract is straight forward. From a risk perspective, it involves the buyer absorbing price risk that the seller is seeking to eliminate. A spread contract is an obvious alternative to a fixed price contract. It is nearly identical to a basis contract and importantly allows either the buyer or seller to individually transfer the futures portion of their price risk to third parties through the hedging mechanism.

Alternatives involve varying types of option based contracts. Even though there are no futures on durum wheat, option type contracts can be developed with premiums derived from the Black Option Pricing Model. The difference is that here it is applied to durum cash prices, instead of a more conventional futures traded contract. These are appealing in part that growers routinely suggest creating contracts with a floor price. However, floor price contracts, while attractive to growers, involve substantial risks to the buyer, i.e., prices may increase which would adversely impact the buyer, but favorably impact the grower. An alternative is to offer a min/max contract which would have the effect of being a risk sharing contract. In this case, the buyer would provide a floor price guarantee to growers; and, simultaneously, growers would be providing the buyer a ceiling price guarantee. Taken together, these comprise a risk sharing contract.

The spectrum of alternative contracts provide growers with more choices. Those contracts with less risk have value to growers—it allows them to lock in prices within an acceptable range, determined in their contract choice. These mechanisms would allow the buyer better opportunities to control price risk. Price differentials among these choices are actuarially consistent and based on the Black option pricing model. The

buyer would be compensated for providing price guarantees (in terms of a lower purchase price) and growers would have to decide among alternatives that are actuarially sound.

Mechanics and Base Case Assumptions: Mechanically, the price spread to MGEX HRS futures, which addresses competing crop values, is the basis of the underlying value to growers for all contracts. A minimum price contract involves deducting a premium from what the grower would otherwise receive.[4] A Min/Max price contract would be a form of risk sharing contract: the grower is guaranteed a floor; and buyer is guaranteed a ceiling. This spectrum of contracts instills the mechanisms for the buyer to reduce risk substantially—should it decide prudent to pursue alternative price risk management strategies. Min/max contracts provide a natural hedge to both the buyer and seller in that both a ceiling and floor prices is provided. Price risks associated with other contract types can be offset using varying offsetting positions in futures and/or options.

For illustration, we use the general structure of contracts as described above. These are specifically defined below, along with the assumptions used in their derivation.

Contract Type	Feature	Price Level or Adjustment
Fixed Price		850
Spread Price	Fixed spread relative to MGEX futures on HRS	+200c/bu over MGEX
Minimum Price 800	Price established by deducting the option value of the implied minimum	-64
Minimum Price 850		-89
Min/Max Price 800/900	Price established by deducting the value of a put option, and adding the value of a call option	Net price adjustment=+5

* Prices here are basis Minneapolis. In practice and below, a deduction is used to establish a local price.

The spread contract would be a fixed spread relative to a defined MGEX futures month, e.g., December. The minimum price contract would provide a minimum price of $8.00/bu (or $8.50/bu). If prices exceed this price at some prescribed time, the grower would receive the higher price. A deduction would be made from the fixed price contract by the value of the premium as shown in the table. If a higher minimum were specified, it could be provided, but, at a greater discount (implied option premium) to the grower. Finally, a min/max contract as defined here is for a minimum price for durum at

[4] Appendix A shows and describes the option premiums used here which are applied on cash durum values.

$8/bu, and a maximum at $9/bu.[5] Here, the net adjustment (e.g., the implied put and call are 51 and 56c/bu respectively) is +5c/bu. Implicitly, this means the grower would be getting a higher net price, by 5c/bu which is ultimately due to the different values of the puts and calls for this contract.

Finally, using these, local prices were derived by deducting 100 c/bu to represent a typical grower price in western North Dakota. These values are summarized in the following figure that shows the price that would be expected by growers, and buyers, under different contracts (Figure 5).

The preferred contract obviously depends on whether the overall wheat market increases or decreases. Here, in addition to a fixed price and spread contract, there are two minimum price contracts, $7.00 and $7.50/bu, and a min/max contract. It is clear here that a minimum contract is preferred if futures are expected to increase. However, a minimum price contract should have a greater discount that a min/max contract as illustrated in the table and figure above.

An important feature of the option based contracts is the deduction for the premiums. Deducting a premium to derive a minimum price contract is conventional. In this case, since there are no futures, it would be equivalent to the buyer providing a put

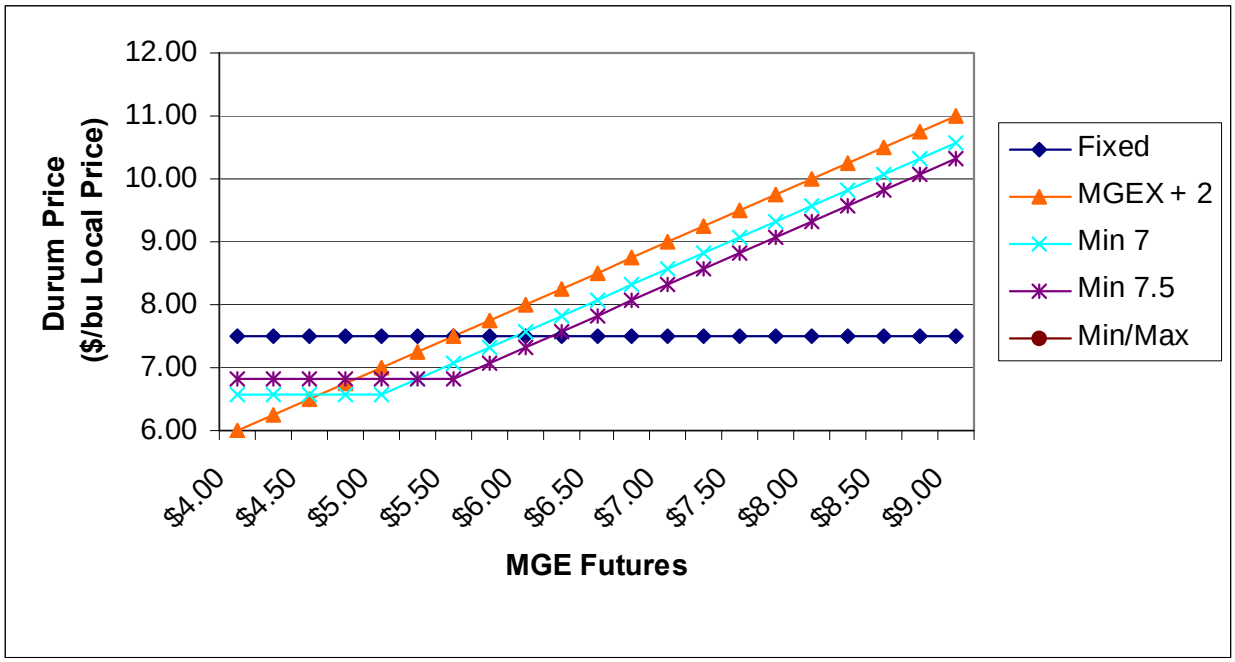

Figure 5. Relationship Between Durum Local Price and MGEX Futures, by Contract Alternative.

[5] Alternatively, a contract could be defined where there is a min/max provision for the spread, instead of the price level. These are not pursued at this time.

option to the grower. This means that offering a Minimum feature is a form of price insurance. However, it is risky for the buyer. If provided free, growers would always take it (i.e. free insurance). For this reason, it is important to offer this as an alternative, at a price differential. Offering a higher minimum is of more value. In practice, it is important to reflect the "insurance value" of the minimum in contract price differentials. The Minimum's can be chosen to reflect the cost of production and alternative minimums can be offered easily.

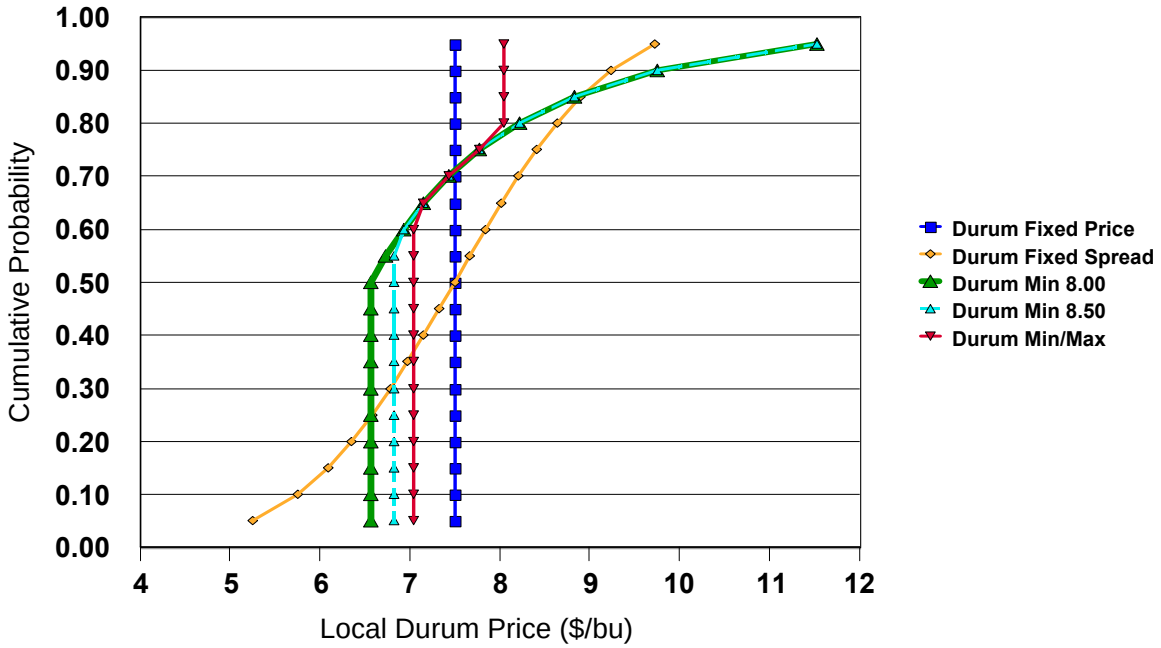

Figure 6. Distribution of Resulting Price Distributions for Alternative Contracts, Local Prices (North Dakota CRD 1), Acceptable Quality.

The Min/max contract is a bit novel. Here the buyer provides growers a guarantee of a minimum (i.e. provides a put option to growers). Simultaneously, the grower provides the buyer a guarantee of a maximum price which would be equivalent to a grower providing a call option to buyer. For this reason, a Min/max contract can be interpreted as risk sharing. The differential between the value of the put and the call is applied to the contract price. Here, the call has a slightly greater value than the put, so, buyer would be paying a net premium to growers choosing this type of contract.

Simulation on Prices:

Since these are each derivative contracts (with exception of the fixed price contract), their values depend on the outcomes of other variable(s). To illustrate the prospective characteristics of prices that may emerge for the alternative contracts, we

simulated these using monte-carlo methods. Distributions that were used are described below. Local prices assumed at $1.00/bu spread relative to Minneapolis prices (i.e., Minneapolis HAD is $2.00 over MGEX HRS futures, and, prices in North Dakota are assumed $1.00 under Minneapolis).[6] See Figure 6 and Table 2 for the results.

From a risk perspective (comparing the standard deviation), the minimum price contracts have the greatest risk for both growers and the buyer. This is, in part, due to while the minimum prices reduce variability on the lower end of prices, volatility when prices increase is retained. Contracts with lesser risk (see the coefficients of variation in Table 2) are the fixed price contract, followed by min/max which would have the 2nd least risk amongst the alternatives; followed by the fixed spread contract. Contracts with lesser risk should be of greater value to both growers and the buyer; hence the motivation to providing more alternatives. Growers which are risk averse, should prefer the latter contracts (fixed price and min/max).

Table 2. Parameters for Input (Mpls) and Resulting Price Distributions for Acceptable Quality (Local Prices).

	Mean	Std. Dev.	Coef. of Var	Minimum	Maximum
Input Values					
MGEX Futures	6.50	1.36	0.21	1.57	11.78
Minneapolis Hard Amber Durum	8.27	2.06	0.25	6.34	20.36
Resulting Price Distributions for Alternative Contracts (Local Prices)					
Durum Fixed Price	7.50	0	0	7.50	7.50
Durum Fixed Spread	7.50	1.36	0.18	2.57	12.78
Durum Minimum 8.00	7.57	1.87	0.25	6.57	19.36
Durum Minimum 8.50	7.71	1.80	0.23	6.83	19.36
Durum Min/Max	7.34	0.42	0.06	7.05	8.05

Other Contract Terms:

Premiums and Discounts for Quality Deviations: This is a very important provision. Barrett (2009) indicated that one of the top 10 contract points is to "Include provisions in your contracts that spell out how, where and when quality discounts, and premiums are to be determined." Some contracts treat quality deviations to apply at market values at

[6] Distributions are presented in the data section.

harvest. Others are premiums and discounts that are pre-specified in the contract prior to planting. At issue here is whether the buyer or seller absorbs the price risk of quality deviations.[7]

Right of First Refusal on Surplus Production: This is a common clause and most buyers will want this right. At issue is at what price. Some contracts provide this right at market prices (as opposed to contract prices). Others do so at some prescribed price differential (at time of contracting).

Storage Options: Most contracts require on-farm storage along with a buyers call. Storage fees following specified time and on-farm samples submitted. However, some require sampling and testing at delivery. Contracts with on-farm storage options impose risk on the farmer that grain quality will deteriorate and it is not covered by crop insurance provisions, other than for potatoes, that have a separate storage rider.

Agronomics: Finally, most contracts use certified seed bought from the buyer. And, it is common to declare or buyer recommends acres for specified production.

Risk and Contracting: Case Study on Durum Wheat

For illustration of issues related to risk and risk sharing, we show a detailed analysis of premiums that should be included in contracts for durum wheat. This crop has experienced problems similar to malting barley; in fact they are nearly identical. Traditionally, it has been a spot commodity and contracts were not used. Basically, supply exceeded demand and there was no need to contract. Over time there has been a decline in acres planted, ultimately to the point that the industry has had to rely more on imports. Reasons contributing to this include disease (i.e., vomitoxin), changing agronomic competitiveness, a change in the geography of production and Canadian competition. The primary competing crops to both durum and malting barley are hard red spring (HRS) wheat and canola, etc, in addition to soybeans, and up to 6-8 other more specialty grains. However, the difference between durum and malting barley has been that durum acres have continued to decline in recent years, while malting barley has increased in recent years, in part due to more assertive contracts.

There is substantial risk in the production of durum. These are primarily related to price, quality and yield and all relative to the primary competing crop, in this case HRS. These are summarized in Table 3. Specifically, price risk is more volatile than HRS, and there is no public market for hedging, in contrast to HRS that can be readily hedged. There is limited (traditionally) transparency in forward contract values. Yields have similar risk. Yield risk has increased in recent years in part due to the shift in

[7] See Wilson and Dahl (2010) cite a recent legal dispute registered in Montana (Johnson) in which grain was sold in a pre-harvest contract with post harvest price discounts specified. Upon delivery the buyer allegedly applied different and more stringent discounts, no doubt reflecting the market in which the grain was being sold. This illustrates the nature of issues about pre-harvest specification of post-harvest discounts.

geography of production (i.e., it has shifted to regions more prone to drought). Finally, there is greater quality risk which is comprised of two parts. One is the risk of not conforming to No. 1 and 2 requirements (grade, falling numbers, protein, etc). The other is the discounts that would apply if rejected which are highly risky. In addition, there are slight differences in crop insurance provisions.

Table 3. Elements of HRS and Durum Risks

	HRS	HAD
Futures (Cash Price for Durum)		
Mean	$6.50	$8.26
(Std. Dev.)	(1.36)	(2.05)
Basis		
Mean	$0.76	$1.00
(Std. Dev.)	(0.58)	
Yield		
Mean	29.4 bu/a	28.5 bu/a
(Std. Dev.)	(2.4)	(2.1)
Quality Acceptance	.64	.38
(Rejection)	(.36)	(.62)
Quality Discount		Triangular ($0,$1,$4/bu)
Mean	$-0.20	$-1.67
(Std. Dev.)	(0.14)	(0.85)

Source: Based on distributions from the data described below (Table 4).

Methods to Evaluate Risks on Contracting: Durum Wheat

Risk is a result of variability in yield, price, quality, and acceptance. Stochastic simulation is used to simulate payoffs for the alternative contracting strategies. Distributions of net returns are then compared using Stochastic Dominance with Respect to a Function (SDRF) and Stochastic Efficiency with Respect to a Function (SERF) to determine risk efficient decisions and to examine effects of risk aversion on preferences.

Contract Types

A base case was simulated to derive returns over direct costs for two HRS alternatives; HRS Unpriced where prices were random and HRS hedged where a portion of production is assumed hedged with futures with a hedge ratio of 1 and the

remainder is random. Then seven alternatives for durum; Durum Unpriced with prices random and 6 with different price contracts on a fixed portion of expected production. The contracts were assumed to be limited to the first 20 bu/a of production with remaining production prices random. For contracts without AOG clauses, production shortages require purchasing at random prices to fill out the contract.

There were six pricing provisions including:

1) Durum Fixed Price assumes a portion of expected durum production is sold on a fixed price contract;

2) Durum Fixed Spread contract assumes a portion of expected durum production is sold on a fixed spread over Minneapolis HRS futures.

3-4) Durum Minimum 8.00 and Durum Minimum 8.50 are minimum price contracts for a portion of expected production, where contract prices reflect the maximum of current random prices or a minimum price. Minimums were $8.00/bu and $8.50/bu Minneapolis reduced to a local price and reduced for a premium reflecting the vanilla option value (see Appendix A) for a hypothetical option for extending the minimum price contract. Based on these, local values for minimum values were $6.57/bu and $6.83/bu.

5) Durum min/max was for a min/max contract alternative were a portion of expected production was sold at a random value as long as it was between a specified minimum and maximum range. This was based on a Minneapolis price reduced to a local price less the implied option value for the min/max contract. The minimum/maximum prices were $8-$9/bu Mpls, which translated to $7.05-8.05/bu local prices.

6) Durum Fixed Price AOG was a fixed price contract with an AOG clause applied on a portion of expected production.

The difference between 6 and 1 is the AOG clause contained in the latter. Here, if production did not meet contracted volumes, only the available production would have to be delivered for sale at contract prices.

Mathematical Description of Model

A payoff function is defined as net returns over variable cost per acre[8] or: Π_i= gross revenue – direct costs for choice i, where i = 1...n, for each crops (HRS or durum). Returns are defined in Equations 1-3 for producers without a contract, with a

[8] To be clear, this is not intended to depict a profit function which would in addition deduct costs such as land and other fixed costs of production. The implicit assumption is that these would be the same across crops and hence their inclusion would not impact the results.

contract without AOG provisions, and with a contract with AOG provisions, respectively:

$$E(\Pi_{i_{nocont}}) = \hat{Y} \cdot (\hat{P}_1 \cdot \hat{S}_i + \hat{P}_2 \cdot (1 - \hat{S}_i)) + (indemnitypayment) - C_i \quad (1)$$

$$E(\Pi_{i_{cont}}) = Y_c \cdot (\hat{P}_3 \cdot \hat{S}_i + \hat{P}_4 \cdot (1 - \hat{S}_i)) \quad (2)$$

$$+ Max(Y_c - \hat{Y}, 0) \cdot ((\hat{P}_3 - \hat{P}_1) \cdot \hat{S}_i + (\hat{P}_4 - \hat{P}_2) \cdot (1 - \hat{S}_i))$$

$$+ Max(\hat{Y} - Y_c, 0) \cdot (\hat{P}_1 \cdot \hat{S}_i + \hat{P}_2 \cdot (1 - \hat{S}_i)) + (indemnitypayment) - C_i$$

$$E(\Pi_{i_{contAOG}}) = Y_c \cdot (\hat{P}_3 \cdot \hat{S}_i + \hat{P}_4 \cdot (1 - \hat{S}_i)) \quad (3)$$

$$+ Max(\hat{Y} - Y_c, 0) \cdot (\hat{P}_1 \cdot \hat{S}_i + \hat{P}_2 \cdot (1 - \hat{S}_i)) + (indemnitypayment) - C_i$$

where: $E(\boldsymbol{\Pi}_i)$ is the expected net return per acre of crop *i*, $\mathbf{Y}$ is the yield (bu/a), $\mathbf{Y}_c$ is the volume contracted (bu/a), $\mathbf{P}_1$, and $\mathbf{P}_2$ are random local prices with no contract when quality is met, and quality not met, $\mathbf{P}_3$ and $\mathbf{P}_4$ are local prices for contracted volumes with quality met, and quality not met, respectively ($/bu) and may be fixed or random based on the type of contract; *indemnity payment* is the value of the payoff if insurance is collected on yield shortfalls; $\mathbf{C}_i$ is the direct cost of production for crop i and includes seed, herbicides, fungicides, insecticides, fertilizers, fuel, repairs, interest and crop insurance and is the same across strategies, but varies by crop (HRS vs durum). Quality acceptance risk is modeled using $\hat{\mathbf{S}}_i$ which is a binary variable reflecting quality which is drawn based on acceptance rates for the highest quality durum or hard red spring. The ˆ indicates the variable is random and a distribution is used for its value. Indirect costs such as land and taxes are excluded because they are fixed and constant across crops and choices.

Several sources of risk impact whether to contract. Most important is the risk of not being acceptable for the highest quality level. The most frequent factors resulting in not being acceptable would likely be durum color, test weight, sprout damage, vitreous kernels and vomitoxin resulting in excess deoxynivalenol (DON). Other risks are yields, prices and discounts applied for not meeting specifications.

There are three steps in our analytical methodology. First, we derive the $\boldsymbol{\Pi}_i$ for each alternative coverage level and contracting strategy. Second, we use stochastic simulation to iterate outcomes of $\boldsymbol{\Pi}$ for each crop and contract alternative. Third, Stochastic Efficiency with Respect to a Function (SERF) was applied using *Simetar* (Richardson, Schumann, and Feldman, 2005) to estimate the certainty equivalents that decision makers would place on a risky alternative relative to a no risk investment. Certainty equivalents are estimated across a range of Arrow-Pratt absolute risk aversion coefficients and used to rank preferences across alternatives. The range of absolute risk aversion coefficients (ARAC) was from 0 to 0.117 where the upper bound for the ARAC was estimated using McCarl and Bessler's non-negativity certainty equivalent approach. Risk premiums were measured as the difference in certainty equivalents relative to the HRS Hedged strategy. The premium indicates the necessary change in the certainty equivalent of net payoffs to equalize net returns across crop/contact choices. These can be used to infer ranks.

Data

Comparative crop budgets included direct costs for both durum and hard red spring wheat production in Northwestern North Dakota for the 2009 crop year (Swenson, 2008). Direct costs included those for fertilizer, herbicides, insecticides, seed, fuel, repairs, operating interest, and crop insurance and were representative of northwestern North Dakota. Random variables in the comparative crop budgets included yields, prices, and crop quality discounts (Table 4). Adjustments for insurance payouts were included for crop yield shortfalls assuming 70% coverage for yields and 100% price level ($6.70 for HRS and $6.50 for durum, USDA-RMA). Yield distributions were fitted from annual data from 1995 to 2007 for crop reporting district 1 in Western North Dakota from USDA-NASS.

Distributions for futures, protein premiums/discounts, and durum prices were similarly fitted from annual data from 1995 to 2007 to determine variability, where means of futures for HRS and cash prices for durum were adjusted to current levels for September futures on 1/6/09 (7.06) and new crop bids for durum of (7.61). Probability of crop quality meeting specifications was determined from U.S. Hard Red Spring Wheat (Minnesota, Montana, North Dakota, South Dakota) and U.S. Northern Grown Durum Wheat (Montana, North Dakota) crop quality surveys from 1995 to 2007 which indicated probability of meeting No. 1 HAD for durum or proportion 14% protein or higher for HRS. For HRS, if specifications were not met, the protein discount for 13% protein wheat from 14% protein premium was applied.

For durum, if quality specifications are not met, a discount was applied for what is referred as terminal durum. Determination of the discount applied is fairly problematic. There is limited historical data published on price spreads in the durum market. The best is that in *Milling and Baking News*. These data show discounts for amber durum of 10 c/bu and for durum of 10-40 c/bu. where data from 2007 forward exhibit no variability from these levels. But upon discussion with traders, they indicate that in recent years these discounts are much more random and much greater. These discussions were the basis to use the discount distribution that was applied. Discounts were assumed to be represented by a triangular distribution with minimum, most likely and maximum values of 0, $1 and $4/bu, respectively. This reflects the minimum, most likely and maximum spreads between Minneapolis durum prices and prices received by growers in North Dakota Northwest crop reporting region (North Dakota Agricultural Statistics Service) after adjusting for a $1.00 transportation basis from local area to Minneapolis.

Random draws for yields of HRS and durum are correlated (.81) and prices and probabilities of meeting quality were correlated (Table 5). For HRS, prices were estimated from random draws for acceptable quality for delivery to both Minneapolis and the Pacific Northwest. Since northwestern North Dakota farmer prices can be influenced by prices/demand at Minneapolis and the Pacific Northwest, the local price is

derived as the *MAX*[net returns selling to PNW, net returns selling to Mpls]. These are used to determine returns over variable costs assuming recent shipping costs from western North Dakota.

Table 4. Distributions and Parameters for Random Elements in comparative Crop Budgets.

Item	Distribution	Mean/Probability	Std. Dev.
Yield HRS	Logistic	29.43	2.41
Yield Durum	Logistic	28.49	2.08
HRS Quality	Discrete (1 or 0)	.64 quality met	
Durum Quality	Discrete (1 or 0)	.38 quality met	
HRS Futures	Normal	6.50	1.36
Mpls Durum	Lognormal	8.43	2.83
Durum Discount Quality not met	Triangular	0, $1, $4	
HRS: 14% Protein Premium Mpls	Lognormal	.76	0.58
HRS: 14% Protein Premium PNW	Normal	.97	0.21
HRS: 13%-14% Protein Discount	Logistic	-.20	0.14
Variable Costs			
HRS	$111/a		
Durum	$115/a		
Bushels Contracted	20 bushels		

Table 5. Correlations for Random Draws for Prices and Acceptable Quality Distributions.

Item	HRS Fut	14% Mpls	14% PNW	13%-14% Discount	Durum Price	Quality HRS	Quality Durum
HRS Fut	1.00	0.00	0.00	0.00	0.86	0.00	0.00
14% Mpls		1.00	0.91	0.00	0.00	0.00	0.66
14% PNW			1.00	0.00	0.65	0.00	0.00
13% Discount				1.00	0.00	0.00	0.00
Durum					1.00	0.00	0.00
Quality HRS						1.00	0.00
Quality Durum							1.00

*0 = not statistically significant

Simulation Methods

Alternative selling strategies were simulated 5000 iterations using @risk (Palisade), at which time stopping criteria indicated results had settled so that successive iterations would not result in a significant change in distribution parameters. Distributions for each of the selling alternatives were then evaluated using Simetar (Schumann, Feldman, and Richardson, 2006) to estimate certainty equivalents for each of the selling strategies across the range of relevant absolute risk aversion attitudes. The upper range for absolute risk aversions was determined following McCarl and Bessler, 1989. Risk premiums were derived as the difference in certainty equivalents relative to a base strategy which here is assumed as growing HRS with a hedged strategy.

Results

A base case was simulated of returns over direct costs for two HRS alternatives, HRS Unpriced where prices were random, and HRS Hedged where a portion of production (20 bu/a) is assumed hedged with futures with a hedge ratio of 1 and the remainder is random. Seven alternatives for durum, Durum Unpriced with prices random and 6 alternatives with different price contracts on a fixed portion of expected production (this was assumed to be limited to the first 20 bu/a of production with remaining production prices random and for those without AOG clauses, production shortages require purchasing at random prices to fill out the contract) as defined above.

Base Case

Distributions for returns over direct costs for each of the alternatives varied across alternatives (Table 6). Average returns were highest for the two HRS alternatives, HRS Unpriced and HRS Hedged at $80/a. For the durum alternatives, Durum Unpriced had an average return of $63/a, while Durum Fixed Price, Fixed Spread, and Fixed Price AOG contracts were higher averaging $67/a. The durum min/max strategy had slightly lower average returns of $64/a, while both of the minimum contracts had the highest average returns of the durum contracts, averaging $69 and $72/a for the Minimum 8.00 and Minimum 8.50 contracts, respectively.

Variability of returns over direct costs was lower for HRS (Hedged alternative standard deviation = $34/a) and was much greater for the durum (unpriced standard deviation = $74/a). It is also high for the durum minimum contracts (standard deviation: Minimum 8.00=$70/a and Minimum 8.50=$69/a). The lowest variability of the durum contracts was for the fixed price contracts with and without AOG, both with standard deviations of $44/a. Distributions for the alternatives also were positively skewed toward more positive values and had kurtosis (distributions tended to be more spiked than normal distribution). Thus, more observations are clustered near the mean than near the tails. The implication of this is that more skewed alternatives would have a

higher probability of achieving a return greater than the mean and those with higher kurtosis are more likely to be near the mean than those with lower kurtosis values.

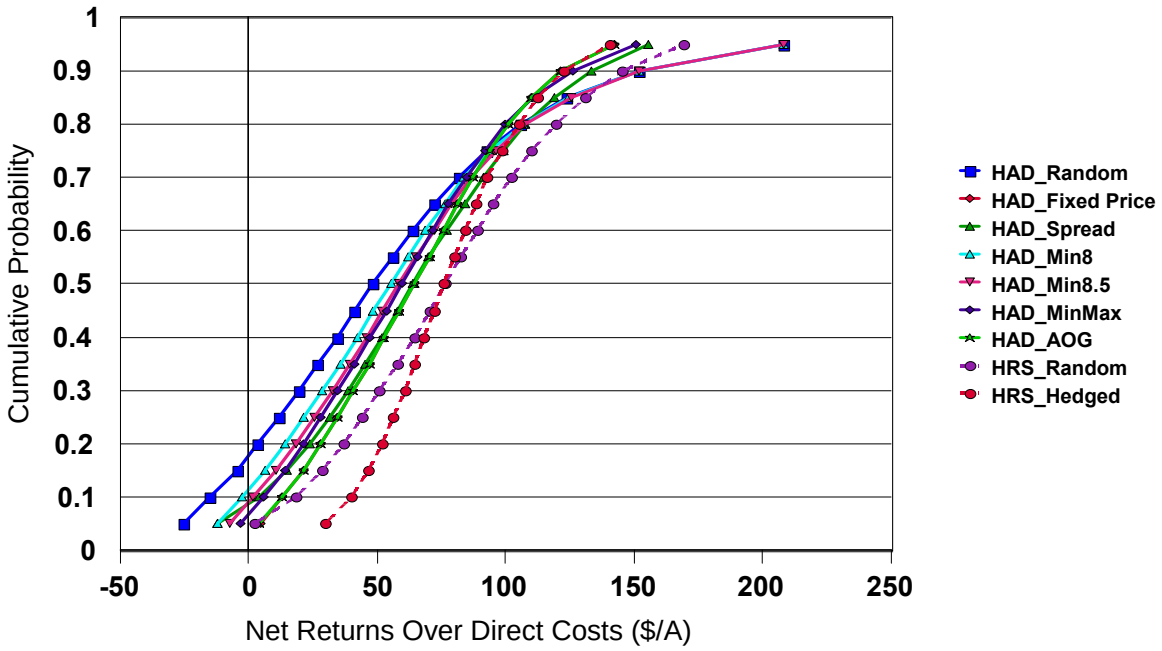

Figure 7. Distribution of Returns Over Direct Costs For HRS and Durum by Alternative.

Table 6. Results for Simulated Distributions of Returns Over Direct Costs, by Strategy.

	Mean	Std. Dev.	Minimum	Maximum	Variance	Skewness	Kurtosis
HRS Unpriced	80	51	-52	366	2601	.51	3.70
HRS Hedged	80	34	1	366	1174	.94	5.36
Durum Unpriced	63	74	-47	560	5432	1.61	6.89
Durum Fixed Price	67	44	-30	364	1929	.73	4.25
Durum Fixed Spread	67	52	-76	346	2667	.46	3.63
Durum Minimum 8.00	69	70	-44	560	4909	1.75	7.61
Durum Minimum 8.50	72	69	-40	560	4720	1.79	7.86
Durum Min 8 Max 9	64	48	-39	375	2322	.81	4.20
Durum Fixed Price AOG	67	44	-30	364	1929	.73	4.25

Distributions for the alternatives were utilized to estimate certainty equivalents for each of the alternatives for a range of grower risk attitudes ranging from risk neutral (ARAC=0) to highly risk averse (ARAC=.117). Ranking the alternatives by certainty

equivalents show that risk neutral growers would prefer the HRS and HRS Hedged as most preferred alternatives with all durum alternatives having lower certainty equivalents (Top row in Table 7). Of the durum alternatives, the two minimum price contracts had the highest certainty equivalents, indicating these are the most preferred durum alternatives for risk neutral growers.

For more risk averse growers (ARAC's increase or as we move down the table), the Durum Fixed Price without AOG quickly becomes the most preferred durum contract, the Durum Fixed Price with AOG becomes the second preferred durum contract, while the min/max contract becomes the third preferred durum alternative. These are followed by the two minimum price contracts (Minimum=$8.50) as fourth and (Minimum=$8.00) fifth preferred durum alternatives.

Differences between certainty equivalents are the risk premium required for growers to be indifferent between alternatives compared and reveal the degree of preference of one alternative over another. Risk premiums were derived relative to the HRS hedge strategy (Table 8). These show that for risk neutral growers, all of the durum alternatives have negative risk premiums indicating they are less preferred to the HRS hedge strategy. Risk premiums for risk neutral growers for the durum alternatives ranged from a low of $-8.35/a for Minimum $8.50 alternative to a high of $-17.24/a for Durum Unpriced. For example, risk neutral growers would require reductions in variability and/or increases in returns that increase the certainty equivalent for the Minimum $8.50 contract by $8.35/a before they would be indifferent between the Minimum $8.50 contract and HRS Hedged.

For more risk averse growers, the risk premiums for durum alternatives relative to the HRS Hedged strategy become more negative. This indicates that more risk averse growers would prefer HRS Hedged to the durum alternatives by larger values. The most risk averse growers would prefer HRS Hedged to Durum Fixed Price without AOG by $28.28/a, Fixed Price with AOG by $28.32/a, Min/Max by $35.59/a, Minimum $8.50 by $39.11/a, Minimum $8.00 by $43.15/a, Durum Unpriced by $53.74/a and Durum Fixed Spread by $60.67/a.

Table 7. Certainty Equivalents for HRS and Durum Alternatives by Risk Attitude (ARAC), $/a.

ARAC	HRS Unpriced	HAD Unpriced	HRS Hedged	HAD Fix Price	HAD Fix Spread	HAD Min 8.0	HAD Min 8.50	HAD Min/Max	HAD FP AOG
0	79.92	62.69	79.92	67.38	67.38	68.76	71.57	64.11	67.38
0.0049	73.83	51.53	77.19	62.91	61.11	58.74	61.93	58.78	62.90
0.0098	68.16	43.23	74.70	58.82	55.25	51.33	54.80	54.03	58.82
0.0146	62.85	36.61	72.38	55.07	49.72	45.42	49.11	49.74	55.06
0.0195	57.83	31.11	70.21	51.60	44.48	40.49	44.34	45.86	51.59
0.0244	53.09	26.40	68.17	48.39	39.51	36.25	40.22	42.33	48.38
0.0293	48.59	22.31	66.24	45.41	34.79	32.52	36.58	39.10	45.40
0.0341	44.34	18.70	64.41	42.65	30.32	29.20	33.34	36.14	42.64
0.0390	40.31	15.50	62.68	40.10	26.08	26.22	30.41	33.42	40.08
0.0439	36.51	12.64	61.02	37.72	22.06	23.52	27.75	30.91	37.69
0.0488	32.93	10.06	59.44	35.50	18.27	21.07	25.32	28.60	35.48
0.0536	29.57	7.73	57.94	33.44	14.69	18.82	23.09	26.46	33.41
0.0585	26.40	5.61	56.51	31.51	11.31	16.75	21.04	24.46	31.48
0.0634	23.43	3.68	55.14	29.71	8.12	14.85	19.13	22.61	29.67
0.0683	20.65	1.90	53.83	28.01	5.12	13.08	17.36	20.87	27.98
0.0731	18.04	0.27	52.58	26.42	2.28	11.43	15.70	19.24	26.38
0.0780	15.60	(1.24)	51.39	24.91	(0.39)	9.89	14.15	17.71	24.87
0.0829	13.31	(2.64)	50.25	23.48	(2.91)	8.45	12.69	16.26	23.44
0.0878	11.17	(3.94)	49.16	22.13	(5.29)	7.10	11.32	14.89	22.09
0.0926	9.16	(5.16)	48.11	20.84	(7.54)	5.83	10.02	13.59	20.81
0.0975	7.27	(6.30)	47.12	19.62	(9.68)	4.62	8.79	12.35	19.58
0.1024	5.49	(7.36)	46.16	18.45	(11.69)	3.48	7.61	11.17	18.41
0.1073	3.81	(8.37)	45.25	17.34	(13.61)	2.39	6.50	10.04	17.30
0.1121	2.23	(9.32)	44.37	16.27	(15.42)	1.36	5.43	8.97	16.23
0.1170	0.74	(10.21)	43.53	15.24	(17.15)	0.38	4.41	7.93	15.21

Table 8. Risk Premiums for HRS and Durum Alternatives Relative to HRS Hedged by Risk Attitude (ARAC), $/a.

ARAC	HRS Unpriced	HAD Unpriced	HRS Hedged	HAD Fix Price	HAD Fix Spread	HAD Min 8.0	HAD Min 8.50	HAD Min/Max	HAD FP AOG
0	0.00	(17.24)	-	(12.54)	(12.54)	(11.16)	(8.35)	(15.82)	(12.54)
0.0049	(3.36)	(25.66)	-	(14.29)	(16.08)	(18.46)	(15.26)	(18.42)	(14.29)
0.0098	(6.53)	(31.47)	-	(15.87)	(19.45)	(23.37)	(19.90)	(20.67)	(15.88)
0.0146	(9.53)	(35.77)	-	(17.31)	(22.66)	(26.95)	(23.27)	(22.63)	(17.32)
0.0195	(12.38)	(39.11)	-	(18.61)	(25.73)	(29.72)	(25.87)	(24.35)	(18.62)
0.0244	(15.08)	(41.77)	-	(19.78)	(28.66)	(31.92)	(27.95)	(25.84)	(19.79)
0.0293	(17.65)	(43.94)	-	(20.83)	(31.45)	(33.72)	(29.66)	(27.15)	(20.84)
0.0341	(20.08)	(45.71)	-	(21.76)	(34.10)	(35.21)	(31.08)	(28.28)	(21.77)
0.0390	(22.36)	(47.17)	-	(22.58)	(36.60)	(36.46)	(32.27)	(29.26)	(22.60)
0.0439	(24.51)	(48.38)	-	(23.30)	(38.96)	(37.50)	(33.27)	(30.11)	(23.33)
0.0488	(26.51)	(49.38)	-	(23.94)	(41.17)	(38.38)	(34.12)	(30.85)	(23.97)
0.0536	(28.38)	(50.21)	-	(24.50)	(43.25)	(39.12)	(34.85)	(31.49)	(24.53)
0.0585	(30.11)	(50.89)	-	(24.99)	(45.20)	(39.75)	(35.47)	(32.04)	(25.02)
0.0634	(31.70)	(51.46)	-	(25.43)	(47.02)	(40.29)	(36.01)	(32.53)	(25.46)
0.0683	(33.18)	(51.92)	-	(25.82)	(48.71)	(40.75)	(36.47)	(32.96)	(25.85)
0.0731	(34.54)	(52.31)	-	(26.17)	(50.30)	(41.15)	(36.88)	(33.34)	(26.20)
0.0780	(35.78)	(52.63)	-	(26.48)	(51.78)	(41.49)	(37.24)	(33.68)	(26.52)
0.0829	(36.93)	(52.89)	-	(26.76)	(53.16)	(41.79)	(37.55)	(33.99)	(26.80)
0.0878	(37.99)	(53.10)	-	(27.03)	(54.45)	(42.06)	(37.84)	(34.27)	(27.07)
0.0926	(38.96)	(53.27)	-	(27.27)	(55.66)	(42.29)	(38.10)	(34.53)	(27.31)
0.0975	(39.85)	(53.41)	-	(27.50)	(56.79)	(42.50)	(38.33)	(34.77)	(27.53)
0.1024	(40.67)	(53.52)	-	(27.71)	(57.85)	(42.68)	(38.55)	(34.99)	(27.75)
0.1073	(41.43)	(53.61)	-	(27.91)	(58.85)	(42.85)	(38.75)	(35.20)	(27.95)
0.1121	(42.13)	(53.68)	-	(28.10)	(59.79)	(43.01)	(38.93)	(35.40)	(28.14)
0.1170	(42.78)	(53.74)	-	(28.28)	(60.67)	(43.15)	(39.11)	(35.59)	(28.32)

These results indicate the value to growers of different pricing and AOG provisions. Here they are evaluated relative to growing HRS that is hedged. Durum is more risky as noted above. For moderately risk averse growers (ARAC=.0293) results indicate

1) A durum grower without any pricing provisions would prefer growing HRS Hedged over durum by about $44/a. That is for growers to be indifferent between Durum Unpriced and HRS Hedged, the certainty equivalent for unpriced durum would have to increase by $44/a. This would likely require some combination of increased durum spot prices relative to HRS, increased probability of meeting quality specifications, increased yields and/or reduced level of price discounts for not meeting specifications, and/or reduced variability in durum prices, durum discounts and yields;

2) A durum fixed price contract without AOG would be most valuable of the durum contract alternatives, but would still be less preferred than HRS Hedged by $21/a. Very close would be a fixed price durum contract with AOG, which would be less preferred than HRS Hedged by $21/a. Hence, the value of the AOG

provisions are virtually nil, or, as shown here are sightly negative. In other words, the value of eliminating effects of yield shortages are overwhelmed by other effects (durum discounts, etc.);

3) Each of the remaining durum contracts are more risky and hence are less valuable to a grower than the fixed price without AOG. Interestingly, contracts with minimum prices and/or min/max provisions and Durum Unpriced would have greater value than a fixed spread contract;

4) The minimum price contracts limit the lower portions of the price distribution, but retain higher prices to growers. As such, these limit the negative variability of prices, but retain the positive price moves. Since the method utilized to estimate certainty equivalents penalizes both positive and negative deviations of returns, these contracts may be viewed less favorably than if analyzed with alternative methods. However, these types of contracts would also have to be viewed favorably by agents extending the contracts who would view the retained positive price variability as increased procurement cost risks.

Sensitivities

Sensitivities were conducted to evaluate changes in several parameters and assumptions for individual contracts and across alternatives. These include alternative prices for fixed price with AOG provisions, alterative spreads for spread over MGEX futures contract, alternative discounts for not meeting durum specifications, alternative volumes contracted, different discounts for extension of AOG provisions, and analysis of adding AOG provisions across contract types.

Alternative Fixed Prices with AOG: The base case alternative for fixed price contract with AOG assumes prices are based on Minneapolis base price of $8.50 per bushel with no discount. Alternative fixed price contracts were modeled with prices ranging from $8.50 to $10.50 in $0.50 increments.

Increasing the fixed price by $0.50 per bushel increases average returns over direct costs by about $10/a on average (Table 9) and also increased minimum and maximum value of returns over direct costs by the same amount. However the standard deviation and other parameters of the distribution were not affected.

Table 9. Results for Durum Fixed Price with AOG for Alternative Base Prices.

	Mean	Std. Dev.	Minimum	Maximum	Variance	Skewness	Kurtosis
Durum Fixed Price AOG							
No Discount $8.50	67.38	43.92	-29.58	364.08	1929	.73	4.25
Fixed Price $9.00	77.36	43.94	-19.58	374.08	1931	.73	4.25
Fixed Price $9.50	87.35	43.97	-9.58	384.08	1933	.73	4.25
Fixed Price $10.00	97.33	43.99	0.42	394.08	1935	.73	4.24
Fixed Price $10.50	107.31	44.02	10.42	404.08	1937	.72	4.24

Stochastic efficiency analysis of the distribution of returns over direct costs for alternative fixed price levels shows that certainty equivalents increased by nearly $10/a for each $0.50 increase in fixed price. This increase in certainty equivalents with an increase in fixed prices was consistent across the range of risk attitudes from risk neutral to highly risk averse growers (Appendix Table B1).

Comparison of risk premiums relative to HRS hedged for the various fixed price alternatives suggests risk neutral growers would start to prefer the Durum Fixed Price with AOG contract over the HRS hedged when fixed prices are $1/bu higher than the base case. The base case assumed Minneapolis durum prices at $2/bu over HRS futures, so, the additional $1/bu premium implies a total premium of $3/bu over HRS futures. At this spread, risk neutral growers would prefer the fixed price contract by $7.42/a over HRS Hedged. More risk averse would prefer HRS Hedged over the fixed price contract at $9.50 Minneapolis. If the fixed price contract is further increased to $10.00 Minneapolis, then growers across all risk attitudes would prefer the durum fixed price contract over HRS Hedged. Preferences for the $10.00 Minneapolis fixed price would range from $17.41/a for risk neutral growers to $1.28/a for highly risk averse growers (Appendix Table B2).

This indicates that to offset the added risk in durum production, the fixed price contract would have to increase by $1 to $1.50/bu over the base case for growers to be indifferent or prefer the fixed price over HRS Hedged. The durum price of $9.50 to $10/bu at Minneapolis and base futures price at $6.50/bu implies a fixed price at $3.00 to $3.50 over Minneapolis futures.

Alternative Spreads for Fixed Spread Contract: In the base case, the fixed spread assumed over MGEX futures was $2/bu. The range for the spread historically has ranged from trading under MGEX to over $5/bu over. The sensitivity of the fixed spread contract for durum relative to MGEX futures was evaluated for a range of spreads ranging from $0/bu to $5/bu over MGEX Futures in $1 increments (Figure 8). . . . . .

Levels for the durum Fixed Spread over MGEX Futures were compared to the durum fixed spread without AOG contract. Increasing the spread over MGEX increases the average return over direct costs, but has no effect on the variability of the distribution of returns (Table 10). Under the increments in spread, it is notable that the fixed price without AOG, has the lower portions of the distribution of returns rotated rightward relative to the fixed spread contracts over MGEX futures (Figure 8). This is also reflected in the higher standard deviations for the spread contracts ($51.64/a) vs. the fixed price contract ($43.92/a).

Since the lower portions of the distribution of the alternative spread contracts is rotated relative to the fixed price contracts, comparisons of certainty equivalents and risk premiums relative to HRS Hedged between the two contracts yields different results (Appendix Tables B3-4). For each level of spread, preferences relative to HRS Hedged have their highest values for risk neutral growers and become larger negative values as

risk aversion increases. At a spread of $3/bu, the fixed spread contract becomes preferred to HRS Hedged for the risk neutral and slightly risk averse, but quickly becomes negative as risk aversion increases. At a spread of $5 over MGEX futures, Durum Fixed Spread is preferred to HRS Hedged for all risk attitudes except for the most risk averse. The level of preference for risk neutral growers for spreads of $3, $4, and $5/bu were $7.46/a, $27.46/a, and $47.46/a, respectively.

Table 10. Results for Returns over Direct Costs for Selected HRS and Durum Alternatives and Durum Fixed Spread by Level of Spread

	Mean	Std. Dev.	Minimum	Maximum	Variance	Skewness	Kurtosis
HRS Unpriced	79.92	51.00	-52	366	2601	.51	3.70
HRS Hedged	79.92	34.27	1	366	1174	.94	5.36
Durum Unpriced	62.69	73.70	-47	560	5432	1.61	6.89
Durum Fixed Price	67.38	43.92	-30	364	1929	.73	4.25
Durum Fixed Spread $0	27.38	51.64	-116	306	2667	.46	3.63
Durum Fixed Spread $1	47.38	51.64	-96	326	2667	.46	3.63
Durum Fixed Spread $2	67.38	51.64	-76	346	2667	.46	3.63
Durum Fixed Spread $3	87.38	51.64	-56	366	2667	.46	3.63
Durum Fixed Spread $4	107.38	51.64	-36	386	2667	.46	3.63
Durum Fixed Spread $5	127.38	51.64	-16	406	2667	.46	3.63

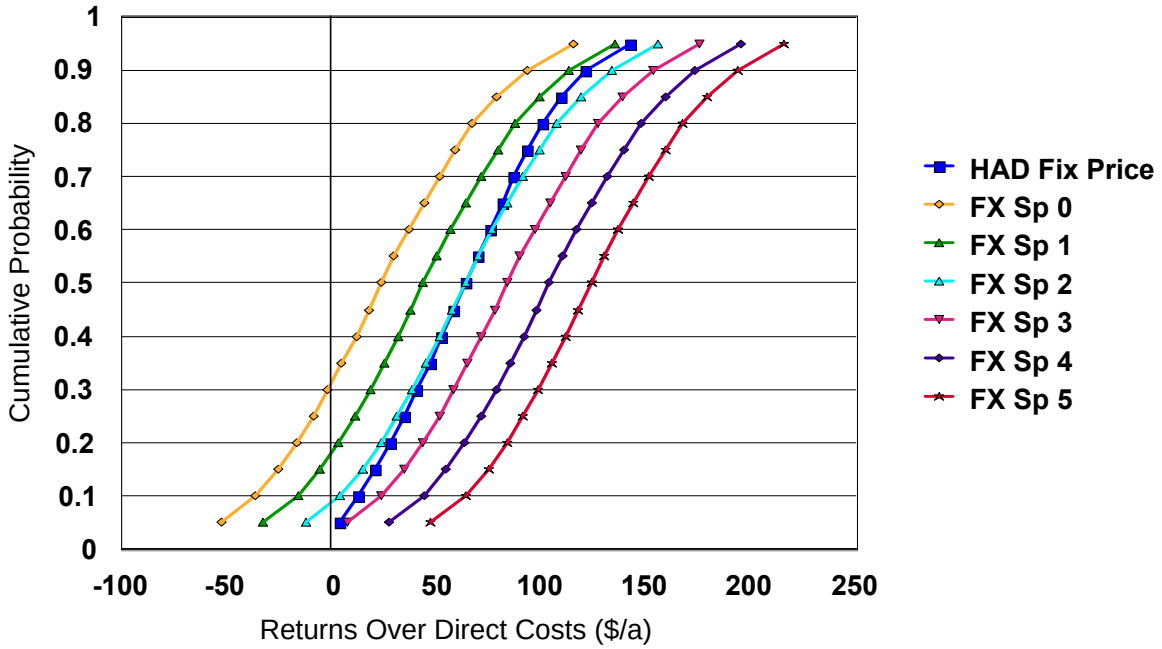

Figure 8. Distribution of Returns over Direct Costs for Durum Fixed Price without AOG and Durum Fixed Spread over MGEX Futures by Level of Spread.

Discounts for Durum Not Meeting Quality Specifications: The base case assumes durum not meeting quality specifications is discounted. The discount levels are assumed represented by a triangular distribution with minimum, most likely and maximum values of $0, $1, and $4/bu, respectively. Post-harvest discounts for durum are risky, non-transparent and about 62% of the crop does not conform to No. 1 HAD on average. Hence, this is a critical factor impacting returns and risk. Two alternative sensitivities were compared including 1) lower mean with lower variability (Triangular ($0, $0.50, $1.25/bu)) and 2) higher level of discount with same range of variability (Triangular ($0, $2, $4/bu)).

Changes in the durum discount distributions resulted in changes in the mean and standard deviations of returns for the contract alternatives. Lowering the mean and variability of durum discounts increased average returns over direct costs by about $19/a and lowered standard deviations by about $8-$10/a. Increasing the most likely value of durum discounts lowered average returns over direct cost by about $5/a and increased standard deviations of returns by about $2/a (Table 11).

Changes in the durum discount distributions had impacts on the certainty equivalents and risk premiums relative to HRS Hedged (Figure 9, Appendix Tables B5-8). Lowering the mean and variability of durum discounts allows durum contracting alternatives to become preferred to HRS Hedged for risk neutral to highly risk averse growers. For risk neutral growers, the Minimum $8.50 is most preferred alternative. As growers become slightly risk averse, the durum fixed price with and without AOG provisions become the first and second preferred alternatives and the HRS Hedged strategy is quickly preferred to the Minimum $8.50 contract. The fixed price alternatives are preferred to the HRS Hedged strategy by $6-8/a across the range of risk attitudes with the AOG provisions being preferred over no AOG by the most risk averse growers by about $0.51/a. These results indicate that durum contracting, primarily the durum fixed price with and without AOG can provide value to growers if the level and variability of durum discounts was reduced.

If the most likely value of durum discounts were increased, risk premiums become more negative by $4-6/a for all the durum alternatives. Thus, increasing the most likely level of durum discounts just makes growers less likely to plant durum as it increases the preference for HRS Hedged over all the durum alternatives by $4-6/a. This reflects the large impact of durum discounts on growers preferences which is consistent across all risk attitudes of growers.

Table 11. Results for Alternative Distributions for Durum Discounts when Not Meeting Specifications by Contract Alternative

	Mean	Std. Dev.	Minimum	Maximum	Variance	Skewness	Kurtosis
Base Case: Triangular (0,.1,4)							
HRS Unpriced	79.92	51.00	-52.49	366.27	2601	.51	3.70
HRS Hedged	79.92	34.27	0.67	365.91	1174	.94	5.36
Durum Unpriced	62.69	73.70	-46.53	559.74	5432	1.61	6.89
Durum Fixed Price	67.38	43.92	-29.58	364.08	1929	.73	4.25
Durum Fixed Spread	67.38	51.64	-76.04	346.06	2667	.46	3.63
Durum Minimum 8.00	68.76	70.06	-43.97	559.74	4909	1.75	7.61
Durum Minimum 8.50	71.57	68.70	-39.98	559.74	4720	1.79	7.86
Durum Min 8 Max 9	64.11	48.18	-38.58	375.08	2322	.81	4.20
Durum Fixed Price AOG	67.38	43.92	-29.58	364.08	1929	.73	4.25
Triangular (0,.50,1.25)							
HRS Unpriced	79.92	51.00	-52.49	366.27	2601	.51	3.70
HRS Hedged	79.92	34.27	0.67	365.91	1174	.94	5.36
Durum Unpriced	81.42	66.55	-16.29	559.74	4428	2.00	8.65
Durum Fixed Price	86.11	34.39	1.99	364.08	1183	1.30	6.96
Durum Fixed Spread	86.11	43.68	-52.93	346.07	1908	.67	4.46
Durum Minimum 8.00	87.50	62.84	-2.21	559.74	3949	2.22	9.80
Durum Minimum 8.50	90.30	61.46	2.99	559.74	3777	2.29	12.24
Durum Min 8 Max 9	82.84	39.04	7.39	375.08	1524	1.31	6.22
Durum Fixed Price AOG	86.11	34.39	13.78	364.08	1183	1.30	6.96
Triangular (0,2,4)							
HRS Unpriced	79.92	51.00	-52.49	366.27	2601	.51	3.70
HRS Hedged	79.92	34.27	0.67	365.91	1174	.94	5.36
Durum Unpriced	57.44	75.58	-51.81	559.74	5713	1.59	6.73
Durum Fixed Price	62.13	45.98	-33.01	364.08	2115	.79	4.08
Durum Fixed Spread	62.13	53.26	-85.00	346.07	2837	.53	3.57
Durum Minimum 8.00	63.51	71.97	-48.68	559.74	5180	1.72	7.39
Durum Minimum 8.50	66.32	70.62	-46.41	559.74	4988	1.76	7.62
Durum Min 8 Max 9	58.85	50.24	-42.01	375.08	2524	.85	4.06
Durum Fixed Price AOG	62.13	45.99	-33.01	364.08	2115	.79	4.08

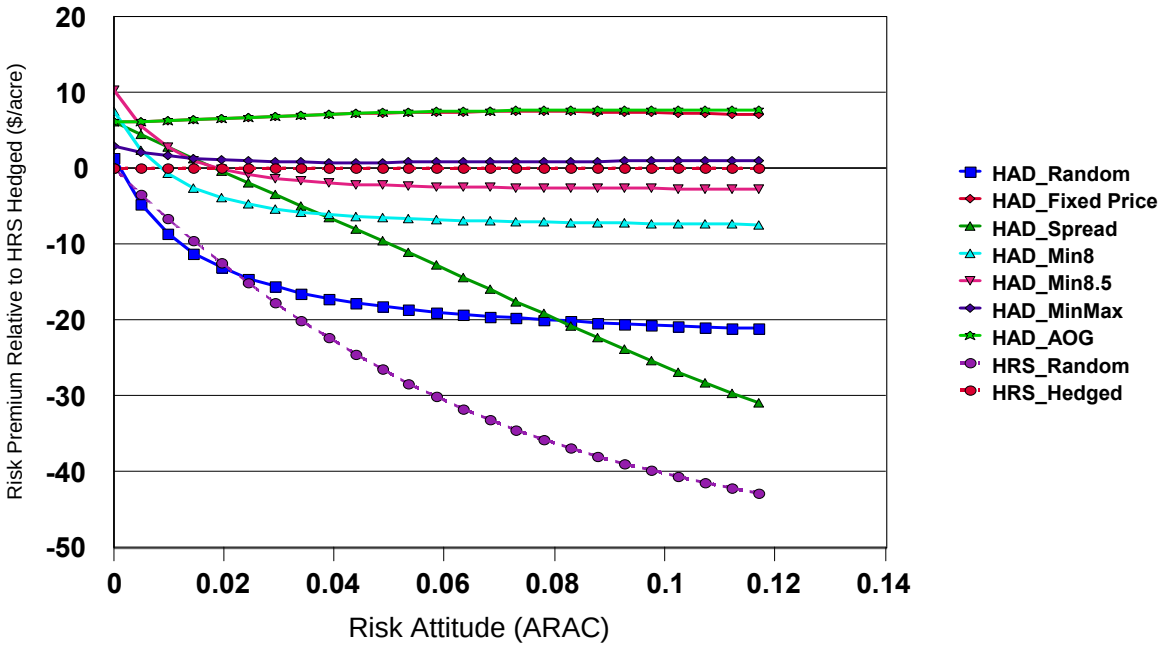

Figure 9. Risk Premiums Relative to HRS Hedged with Lower Variability in Durum Discounts (Triangular ($0, $0.50, $1.25)).

Volume of Crop Contracted: The base case alternatives assume 20 bushels/a are contracted in each of the alternatives vs. an average yield of 28.5 bushels/a (approximately 70% of expected production). Higher and lower levels of expected production were examined to determine the effect on rankings between alternatives which ranged from 10 to 28.5 bushels/a (35% to 100% of expected production).

Changing the volume of crop contracted has limited impact on the average return over direct costs for all the alternatives. The exception is for the two minimum price contracts which increased in value as the volume of bushels contracted increased. However, standard deviations for most of the alternatives exhibited the pattern of decreasing variability as the volume contracted increases from 10 bushels/a to 28.5 bushels/a contracted or 100% of expected production (Table 12). The skewness of the durum contracting alternatives declined as the volume of bushels contracted increased for all but the two minimum contracts, which increased in skewness. This indicates that as more bushels were contracted, distributions for most of the durum contracts became more symmetrical, except for the two minimum contracts which became more skewed toward higher positive values (Figure 10).

Analyzing the alternative contracting strategies for the different volumes contracted shows that all the durum contracts are less preferred that HRS Hedged across all bushel volumes contracted up to 100 percent of expected production. The ranking of preference among the durum contracts and the amount of preference (risk premium) relative to HRS Hedged varied by the level of bushels contracted and the risk

attitude of the grower (Appendix Tables B9-B16). For risk neutral growers, the Minimum 8.50 contract was the most preferred of the durum contracts for all bushel levels contracted. However, once growers shift from risk neutral to even very slightly risk averse, the Durum Fixed Price became the highest ranked of the durum contract alternatives. For the 10-20 bushel contract volumes, the Durum Fixed Price with and without AOG provisions were nearly identical. However, once volumes contracted reached 25 to 28.5 bushels/a, at risk attitudes of about .03 to .02, growers preferred the fixed price with AOG provisions over without. For the 28.5 bushels contracted, this degree of preference increased so that for the most risk averse growers, they would prefer HRS Hedged over Durum Fixed Price with AOG by $18.44/a, but over Durum Fixed Price without AOG by $30.81/a, indicating that at higher bushel levels contracted, the AOG provisions would be valued at up to $12.37/a. However, for the most risk averse growers contracting 25 bushels/a, the value of the AOG provisions would only be $0.98/a.

Risk premiums for Durum Fixed Price without AOG relative to HRS Hedged by contracted bushels were compared by risk attitude of the grower (Figure 11). These show the effect of contracted bushels on the level of preference for HRS Hedged over Durum Fixed Price varies by the risk attitude of the grower. Here the contracted bushel alternative with the highest risk premium relative to HRS Hedged changes as the risk attitude of the grower changes. This indicates that growers using a fixed price contract would prefer to contract different levels of expected production depending on their level of risk aversion. For example, growers that are risk neutral to ARACs of near .05, would prefer contracting 100 percent of expected production over lesser bushel volumes. Those with higher risk aversions would prefer contracting 25 bushels per acre, while the most risk averse growers would prefer only contracting 10 bushels/a.

Table 12. Results for Alternative Bushel Volumes Contracted by Contract Alternative

	Mean	Std. Dev.	Minimum	Maximum	Variance	Skewness	Kurtosis
10 Bushels/A Contracted							
HRS Unpriced	79.92	51.00	-52.49	366.27	2601	.51	3.70
HRS Hedged	79.92	41.26	-15.19	366.09	1703	.75	4.33
Durum Unpriced	62.69	73.70	-46.53	559.74	5432	1.61	6.89
Durum Fixed Price	65.03	57.06	-35.27	461.91	3255	1.26	5.79
Durum Fixed Spread	65.03	58.65	-52.86	452.91	3440	1.17	5.55
Durum Minimum 8.00	65.73	71.81	-43.97	559.74	5156	1.69	7.26
Durum Minimum 8.50	67.13	71.08	-41.97	559.74	5053	1.71	7.39
Durum Min 8 Max 9	63.40	59.79	-39.77	467.41	3575	1.25	5.56
Durum Fixed Price AOG	65.03	57.06	-35.27	461.91	3255	1.26	5.79
15 Bushels/A Contracted							
HRS Unpriced	79.92	51.00	-52.49	366.27	2601	.51	3.70
HRS Hedged	79.92	37.31	0.61	366.00	1392	.87	4.82
Durum Unpriced	62.69	73.70	-46.53	559.74	5432	1.61	6.89
Durum Fixed Price	66.21	49.86	-32.05	413.00	2486	1.01	5.06
Durum Fixed Spread	66.21	53.86	-32.01	399.49	2901	.82	4.55
Durum Minimum 8.00	67.24	70.92	-43.97	559.74	5029	1.72	7.44
Durum Minimum 8.50	69.35	69.86	-40.98	559.74	4881	1.75	7.63
Durum Min 8 Max 9	63.75	53.60	-38.80	421.25	2873	1.03	4.86
Durum Fixed Price AOG	66.21	49.86	-32.05	413.00	2486	1.01	5.06
25 Bushels/A Contracted							
HRS Unpriced	79.92	51.00	-52.49	366.27	2601	.51	3.70
HRS Hedged	79.92	32.38	-8.98	365.82	1049	.89	5.79
Durum Unpriced	62.69	73.70	-46.53	559.74	5432	1.61	6.89
Durum Fixed Price	68.55	39.81	-36.39	315.17	1584	.43	3.52
Durum Fixed Spread	68.56	52.32	-105.66	292.66	2737	.19	3.12
Durum Minimum 8.00	70.28	69.25	-43.97	559.74	4796	1.78	7.78
Durum Minimum 8.50	73.79	67.61	-39.46	559.74	4571	1.83	8.09
Durum Min 8 Max 9	64.46	43.84	-38.35	328.92	1922	.60	3.65
Durum Fixed Price AOG	68.53	39.82	-28.81	315.17	1585	.44	3.52
28.5 Bushels/A Contracted							
HRS Unpriced	79.92	51.00	-52.49	366.27	2601	.51	3.70
HRS Hedged	79.92	31.87	-19.07	365.76	1016	.78	5.88
Durum Unpriced	62.69	73.70	-46.53	559.74	5432	1.61	6.89
Durum Fixed Price	69.38	38.34	-55.18	280.93	1470	.21	3.26
Durum Fixed Spread	69.38	54.47	-126.40	257.47	2967	.07	3.00
Durum Minimum 8.00	71.35	68.71	-43.97	559.74	4721	1.80	7.89
Durum Minimum 8.50	75.34	66.88	-39.46	559.74	4473	1.85	8.23
Durum Min 8 Max 9	64.71	41.61	-39.50	296.60	1732	.46	3.37
Durum Fixed Price AOG	69.16	38.33	-28.81	280.93	1469	.26	3.14

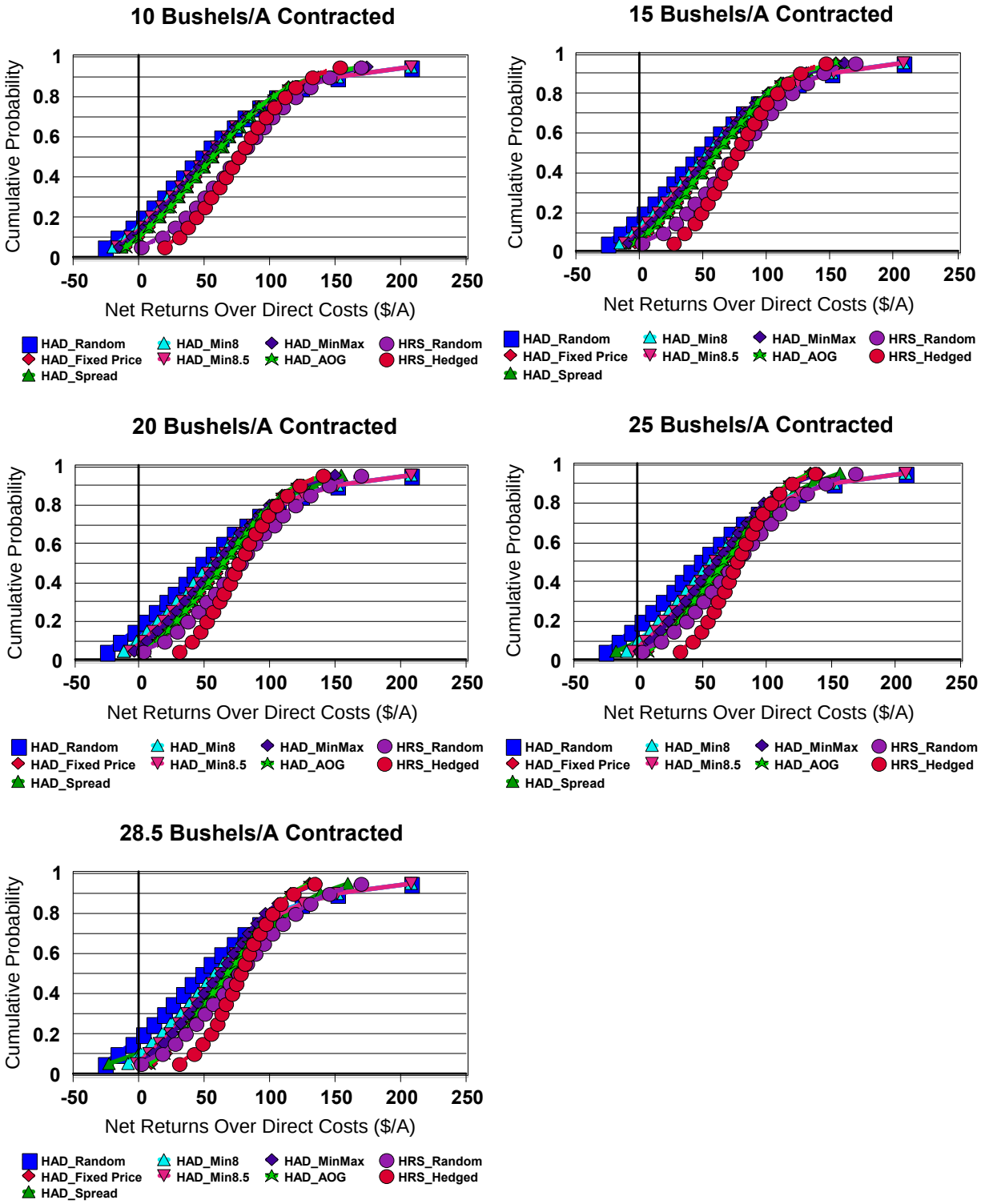

Figure 10. Distributions for Returns Over Direct Costs for HRS and Durum Alternatives, by Bushels Contracted.

The same comparison using the durum fixed price with the AOG is shown in Figure 12. Here, contracting 28.5 bushels/a or 100 percent of expected production is the preferred bushel contracting level across the range of risk attitudes from risk neutral to the most risk averse growers.

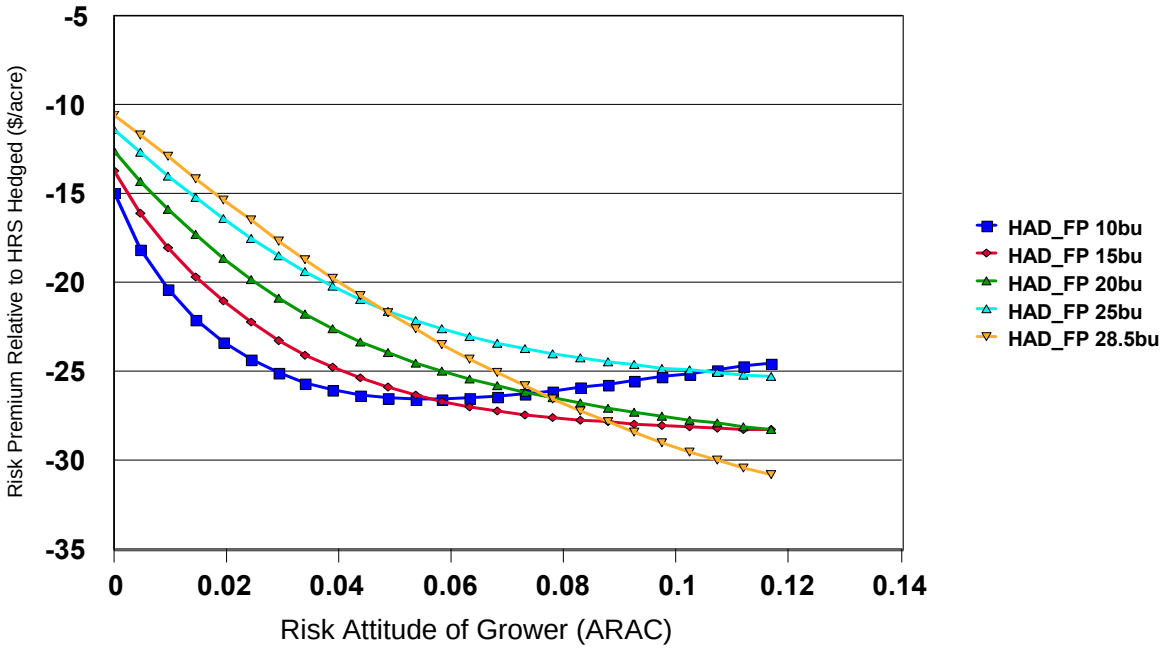

Figure 11. Risk Premiums for Durum Fixed Price without AOG Relative to HRS Hedged, by Level of Bushels Contracted and Risk Attitude of Grower.

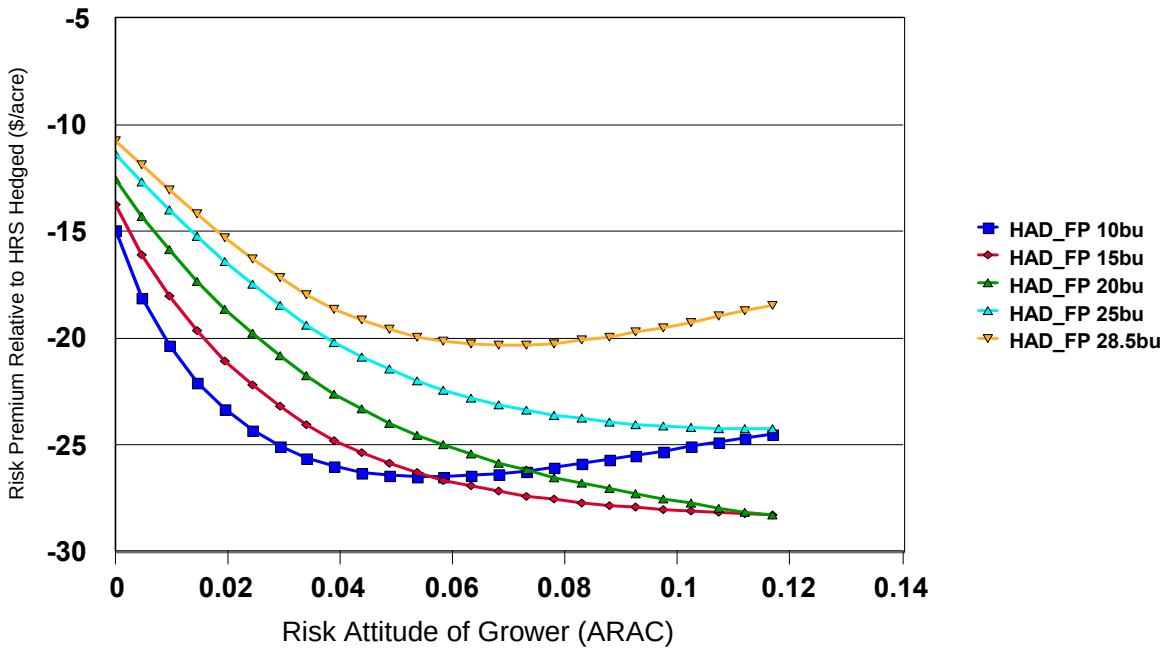

Figure 12. Risk Premiums for Durum Fixed Price with AOG Relative to HRS Hedged, by Level of Bushels Contracted and Risk Attitude of Grower.

Discounts for AOG Provisions in Fixed Price Contract: The fixed price contract with AOG for the base case assumes no discount in prices for the AOG provisions (or no price differential). However, most crop contracts with AOG clauses have some level of discount applied relative to a contract without the AOG. Alternative scenarios for the fixed price contract with AOG were evaluated with discounts for AOG provisions in $0.25 increments from $0 to $1.00/bu.

Increasing the discount reduces the average, minimum and maximum returns over direct costs by about $5.00/a, but has little to no impact on variability or shape of the distribution of returns (Table 13). This in effect shifts the distribution leftward (lower levels of returns occurring for a given probability) by $5.00/a for each $0.25 increase in the discount for the AOG clause (Figure 13).

As the AOG discount increases, the certainty equivalents for the durum fixed price contract decline (Appendix Table B17). For risk neutral growers, the increase in discounts to $0.25 shifts the fixed price AOG alternative to the last ranked alternative from the seventh with no discount (Appendix Tables B17-18). Further, as growers become more risk averse, with no discount, the durum fixed price with AOG alternative quickly becomes the third best alternative behind HRS Hedged and Durum Fixed Price without AOG. For any level of risk aversion, as the level of discount increases, growers rank the Durum Fixed Price with AOG as a worse alternative. As growers become more risk averse, the rankings for any level of discount improve so that for the most risk averse growers, the durum fixed price with AOG is ranked as the third best alternative

for discounts from 0-$.25/bu, fourth for a discount of $0.50/bu to the seventh best alternative for discounts ranging from $0.75 to $1.00/bu.

Interestingly, the durum fixed price with AOG for all levels of discounts ranging from $0 to $1.00/bu result in certainty equivalents that are lower than for the durum fixed price without AOG provisions (Appendix Table B17). This suggests that with the current variability impacting durum returns, AOG provisions do not provide value to growers for the fixed price contract.

Table 13. Results for Durum Fixed Price with AOG by Level of Price Discount Applied for AOG Provisions.

	Mean	Std. Dev.	Minimum	Maximum	Variance	Skewness	Kurtosis
AOG Discounts Durum Fixed Price with							
No Discount	67.38	43.92	-29.58	364.08	1929	.73	4.25
Discount $-0.25/bu	62.39	43.91	-34.58	359.08	1928	.73	4.25
Discount $-0.50/bu	57.40	43.90	-39.58	354.08	1927	.73	4.26
Discount $-0.75/bu	52.41	43.89	-44.58	349.08	1926	.73	4.26
Discount $-1.00/bu	47.42	43.88	-49.58	344.08	1925	.74	4.26

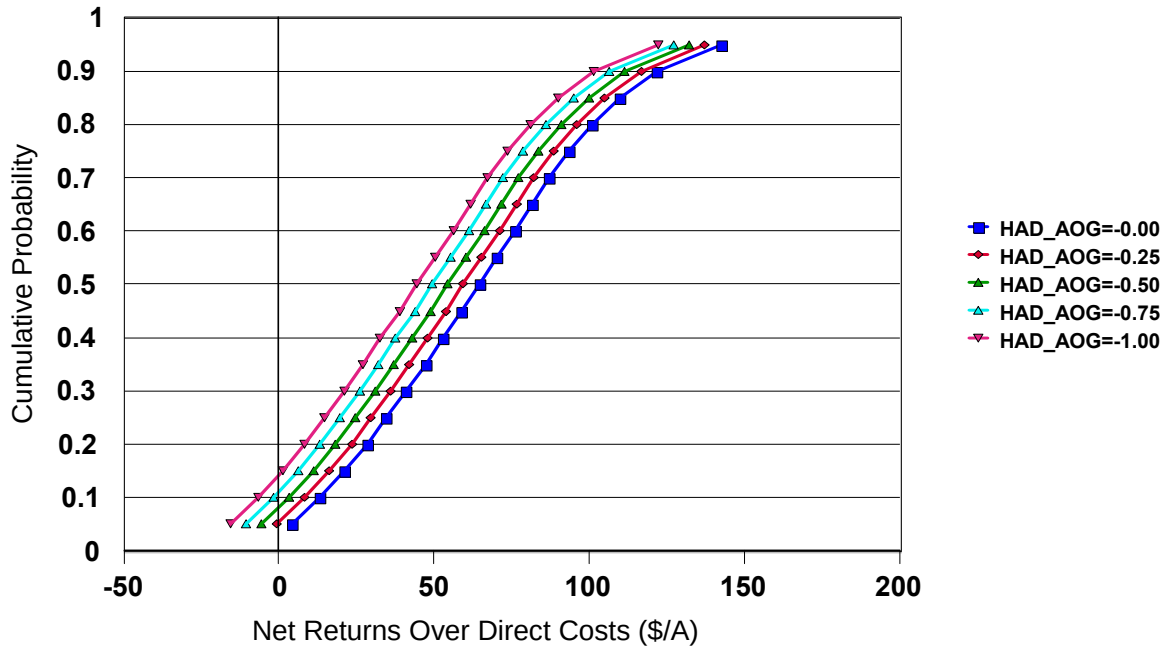

Figure 13. Distribution of Returns Over Direct Costs for HAD Fixed Price with AOG, by Level of Price Discount Applied for AOG Provisions.

Value of AOG Clause by Contract: Each of the durum contracts were modeled both with an AOG clause and without where no discount was applied for the AOG provisions. This allows estimation of the implied value to growers (how much they would be willing to pay) for the AOG provisions. Resulting distributions with (Table 5) and without (Table 14) AOG clauses were very similar. Stochastic efficiency analysis of distributions indicates that AOG clauses change in value as the risk attitude of growers becomes more risk averse (Appendix Tables B19-20). For the fixed spread contract, the difference between certainty equivalents with AOG provisions and base case (without AOG) indicate that AOG provides positive value to growers which increase up to 18 c/a for the most risk averse growers. In contrast, the AOG value for the remaining contracts is negative and declines (becomes more negative) as growers become more risk averse (Figure 14). This suggests that the value of AOG provisions varies widely by the type of durum contract advanced and the risk attitude of the grower and for most contracts provides limited value to durum growers under the current assumptions.

Table 14. Results for simulated distributions of returns over variable costs by strategy with AOG clauses in all durum contracts

	Mean	Std. Dev.	Minimum	Maximum	Variance	Skewness	Kurtosis
HRS Unpriced	79.92	51.00	-52.49	366.27	2601	.51	3.70
HRS Hedged	79.92	34.27	0.67	365.91	1174	.94	5.36
Durum Unpriced	62.69	73.70	-46.53	559.74	5432	1.61	6.89
Durum Fixed Price AOG	67.38	43.92	-29.58	364.08	1929	.73	4.25
Durum Fixed Spread AOG	67.38	51.62	-76.04	346.07	2665	.46	3.63
Durum Minimum 8.00 AOG	68.75	70.08	-43.97	559.74	4911	1.75	7.61
Durum Minimum 8.50 AOG	71.55	68.72	-39.98	559.74	4722	1.79	7.86
Durum Min 8 Max 9 AOG	64.11	48.19	-35.58	375.08	2322	.81	4.20

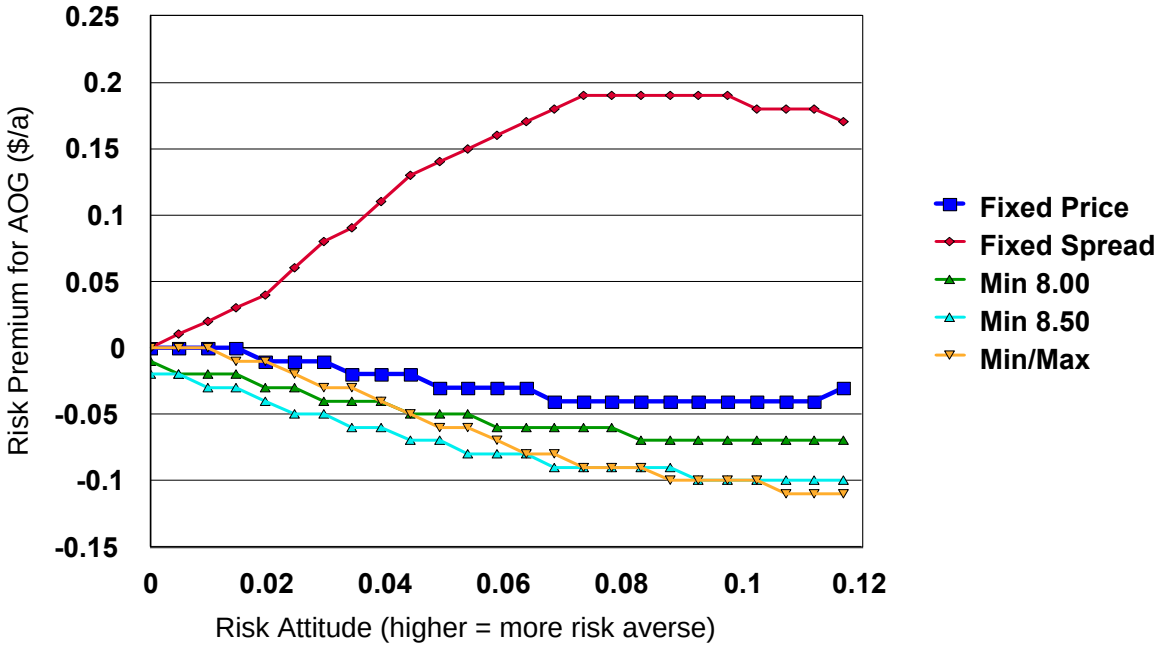

Figure 14. Comparison of Risk Premium for AOG provisions, by Contract and Risk Attitude.

Summary/Implications

There has been growth in the use of pre-plant contracts for many important agricultural contracts. Factors that have contributed to this include the increase in volatility in all aspects of commodity trading and the battle for acres resulting in intense inter-crop competition.

Durum is a crop that has experienced many problems that result in greater risk for both buyers and sellers. Its acreage has decreased substantially in recent years (from about 4 million acres in 2000 to 2.6 million acres in 2009). As a result, buyers have become increasingly more dependent on imports, as well as production from non-traditional regions as sources of supply. There also is greater price risk, spread risk, and there is no futures contract in comparison to HRS which is the principal competing crop. Finally, quality risk is greater, and discounts that would apply to non-conforming production are greater and have greater variability relative to those that would apply to HRS. For all these reasons, there is more pressure for buyers and sellers of durum to explore use of pre-plant contracts as a means to reduce risk for both buyers and sellers.

The purpose of this paper is to analyze contract alternatives and some of the issues confronting the grain industry related to contracting. There are three specific purposes. First, we provide a broad survey of contract terms used in grain contracting with growers. Second, we illustrate some issues in contracting of some of the specialty

grains (durum) in the upper Midwest. Finally, we develop a model to analyze alternative contracting strategies in the case of durum wheat. . . . . .

A range of contract alternatives for durum were posed and compared to unpriced durum, HRS and hedged HRS for northwestern North Dakota. Returns over direct costs were simulated and resulting distributions were compared using stochastic efficiency techniques to determine certainty equivalents and rank preferences for each alternative. Risk premiums relative to HRS Hedged strategy were estimated across a range of risk aversions for growers. Sensitivities were conducted on specific contract provisions (spread for fixed price, size of fixed spread over MGEX, alternative distributions for durum discounts, volume contracted, discount for AOG contract, etc.) to determine their effect on certainty equivalents and grower rankings of alternatives.

Results indicated that unpriced durum has a high degree of risk in returns relative to either HRS unpriced or HRS hedged (standard deviations of $74/a, $51/a, and $34/a, respectively). This is caused by numerous factors but, of particular importance, are the greater price and quality risks for durum versus HRS. The proposed durum contract alternatives reduce some of the variability in returns, especially the durum fixed price (with and without AOG), min/max and fixed spread contracts. The durum minimum price contracts increased average returns over the other durum alternatives by limiting the effects of lower prices, but the reduction in variability was much less than the other alternatives.

Stochastic efficiency analysis indicates that risk neutral to highly risk averse growers would prefer HRS Hedged over the alternative durum contracts. Thus, while the durum contracts (primarily the fixed price with and without AOG provisions) reduced variability of returns, they provide less value to growers and are less preferred than HRS Hedged. Thus, for durum contracting alternatives to become preferred by growers, it would require some combination of reductions in the level and variability of durum discounts for not meeting quality specifications, higher levels and reduced variability in prices, yields, or probability of meeting specifications. Since the probability of achieving increased yields and/or reduced variability of yields of durum relative to HRS varieties are limited, this suggests that contracts should focus on discounts for not meeting specifications, specification limits and controlling for levels and variability of Minneapolis durum prices.

Specific results for moderately risk averse growers (ARAC=.0293) indicate:

1) A durum grower without any pricing provisions would prefer growing HRS Hedged over durum by about $44/a. That is, for growers to be indifferent between durum unpriced and HRS Hedged, the certainty equivalent for unpriced durum would have to increase by $44/a. This would likely require some combination of increased durum spot prices relative to HRS, increased probability of meeting quality specifications, increased yields and/or reduced level of price discounts for not meeting specifications, and/or reduced variability in durum prices, durum discounts and yields.

2) A durum fixed price contract without AOG would be most valuable of the durum contract alternatives, but would still be less preferred than HRS Hedged by $21/a. Very close would be a fixed price durum contract with AOG, which would be less preferred than HRS Hedged by $21/a. Hence, the value of the AOG provisions are virtually nil, or as shown here, are sightly negative. In other words, the value of eliminating effects of yield shortages are overwhelmed by other effects (durum discounts, etc.).

3) Each of the remaining durum contracts are more risky and hence are less valuable to a grower than the fixed price without AOG. Interestingly, contracts with minimum prices and/or min/max provisions and durum unpriced would have greater value than a fixed spread contract.

4) The minimum price contracts limit the lower portions of the price distribution, but retain higher prices to growers. As such, these limit the negative variability of prices, but retain the positive price moves. Since the method utilized to estimate certainty equivalents penalizes both positive and negative deviations of returns, these contracts may be viewed less favorably than if analyzed with alternative methods. However, these types of contracts would also have to be viewed favorably by agents extending the contracts who would view the retained positive price variability as increased procurement cost risks.

There are numerous implications from these results for buyers. Most important is that durum is more risky than competing crops. For slightly risk averse growers, having the ability to utilize a fixed price contract rather than growing durum unpriced, reduces the risk premium the grower would require to be indifferent between planting durum and HRS Hedged from $44/a to $21/a. Thus, for producers to prefer or be indifferent between planting durum and HRS Hedged would likely require some combination of increased durum spot/contract/spread prices relative to HRS, increased probability of meeting quality specifications, increased yields and/or reduced level of price discounts for not meeting specifications, and/or reduced variability in durum prices. In the case of the fixed price contract, increasing the fixed price by $1/bu to $1.50/bu results in growers becoming indifferent between durum and HRS Hedged. In the fixed spread contract, the spread would have to be $3/bu to $5/bu over MGEX futures (depending on risk aversion of the grower with higher values required for the more risk averse growers) for growers to be indifferent between durum and HRS Hedged. Reducing the range of durum discounts from $0 to $4/bu to $0 to $1.25/bu results in the durum fixed price contract with and without AOG and the Min/Max being preferred to HRS Hedged.

From a buyer perspective, the ability to reduce the risk of growing unpriced durum by offering a fixed price contract should increase the likelihood that growers at the margin could plant durum. In the model developed here, growers are evaluated using distributions for yields, meeting quality specification, etc for the marketing region as a whole. Distributions for individual growers within the marketing region may vary from those for the region as a whole. Thus, the ability to offer the contract may, at the margin, influence some portion of growers with different distributions for yields,

probability of acceptable quality, etc., who prior to the contract preferred to grow HRS Hedged, to be indifferent to or prefer planting durum with the fixed price contract.

Finally, there are many types of contract provisions that can be included in contracts. These include numerous different pricing provisions (as illustrated here, up to 6 pricing formulae could be envisioned for durum), AOG, etc. as well as provisions covering the value of post-harvest price discounts for excess production. As it turns out the latter is particularly interesting and important since it has a significant impact on risk. These results indicate that all of these impact the value of contracts and should be carefully analyzed by principals and growers as they envision alternative contracting strategies.

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Appendix A: Vanilla Options for Durum Wheat[9]

Traditional exchange traded options are on futures contracts and include American if early exercise is allowed or European if it allows exercise only at maturity. If the option places a floor on the price it is called a "put" option. If the option places a ceiling on the price it is called a "call" option.

Other types of options exist and are used often for non-exchange traded instruments. These include Vanilla and Asian options. Vanilla options are options that settle to a single spot price. It is similar to the American and European options, but, these have strike prices. Vanilla options settle to a single price on a single date (e.g., last day of the month). Asian options are an option that settles to an average price over a particular time period. The type of implied option depends on two factors: Whether the contract settles to a single spot price or an average price over a specified time period; and whether the option places a ceiling or floor (or both) on the contract price.

The values illustrated in this report were derived analytically and should reflect what would be the value of an option if traded. The values were derived using using the Black options pricing model (BOPM). The necessary inputs are volatility, min and max values, the time to expiration and interest costs. Outputs are prices for premiums for puts and calls for all months forward.

These have a specific interpretation. Technically, the prices should be interpreted as the "fair market value" of the protection, or the insurance value of the option. Values of any analytically derived option premium are the fair market value of the instrument. It is "Fair" in the sense that it is actuarially fair. Buyers should be willing to buy and accept these premiums. And, sellers should be willing to sell or offer options at these values.

Durum prices are not exchange traded in contrast to American puts and calls on futures. If they were, and if adequate numbers of buyers and sellers participated, the observed traded option premiums would converge to these values. Use of non-exchange trade options requires the contractor to implicitly accrue the implied costs of options, or, explicitly reflect costs of option features in a contract.

Vanilla options can be valued using a formula called BOPM. These values are a function of expected price, the price floor or ceiling (Strike Price), time remaining until maturity (in years), expected price Volatility (annualized percentage), and the risk-free Interest Rate (annual percentage). Though the BOPM was originally developed for European style options, it can be used to value vanilla options.

A model was developed to derive premiums for illustration. Sensitivities with respect to critical variables, namely volatilities and different durations forward were

[9]The model and ideas presented in this section build upon previous joint work between the authors and Dr. David Bullock of FCStone, Minneapolis. His input and ideas were both constructive and insightful.

conducted. Volatility is typically derived using historical data. In practice these should be projected volatilities i.e., during the pricing period, and are subject to strategic judgment. The base case premiums for puts (floor), calls (ceiling) and min/max contracts are shown below. These are derived assuming a 3% interest rate, and 30% volatility, for floor and ceiling prices of 700 and 800c/bu, and were derived for different months forward from February 2009.

Three values are derived. One is the floor premium. Second is a ceiling premium. Finally, a min/max premium, which is defined as the difference is derived. These are the basis of the values used for illustration in the text. Several sensitivities are important. One is the time period of coverage. In concept, the further forward a minimum or maximum is guaranteed, the greater should be the premium. Simply, the greater the time to maturity, the greater chance prices will change adversely. As shown here, the put value for a May delivery is 28c, where as those for a September delivery is 47c. This is expected and a product of any form of insurance. For buyers and growers, this simply means that for longer periods of contracting, option premiums should be greater.

	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09
Price Forecast	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Volatility Forecast	30%	30%	30%	30%	30%	30%	30%	30%
Price Floor	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Price Ceiling	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Floor Premium	0.14	0.22	0.28	0.33	0.38	0.43	0.47	0.51
Ceiling Premium	0.16	0.24	0.31	0.37	0.42	0.47	0.51	0.56
Min/Max Premium	-0.02	-0.03	-0.03	-0.04	-0.04	-0.04	-0.05	-0.05

Volatility is one of the important factors impacting option premiums. Greater volatility means greater risk; which means a greater cost (value) to insure prices. As volatility increases, option premiums increase. For illustration, the model was revised assuming volatilities of 10, 20, 30 and 40. The corresponding values for the September 700 put options are: 6, 25, 47 and 69c/bu respectively. Thus, it is clear that as volatility increases, the implied premium increases, which is deducted from grower prices in deriving a guaranteed minimum.

Finally, different premiums would exist for different price floors. Our base case had a price floor of 700c/bu. The premium for this was 47c/bu and in a minimum price contract would be deducted from the base price. For illustration, we derived the premium for price floors ranging from 550c/bu to 950c/bu; and for price ceilings from 950c/bu to 550c/bu. These were all evaluated relative to September 2009 and the results are shown below.

Price Level c/bu	Floor Premium c/bu	Ceiling Premium c/bu
550	7	203
600	15	162
650	28	126
700	47	96
750	71	71
800	100	51
850	135	37
900	173	25
950	214	18

Finally, in summary, it is important that option premiums would be revised during a contracting period. Throughout the contract period, it will be important to revise the option premiums. The most important revisions would be with respect to, in rank order: Date of contracting; potential changes in measures/estimates of volatility; and interest costs

Appendix B. Certainty Equivalents and Risk Premiums for Sensitivities.

Appendix Table B1. Certainty Equivalents by Risk Attitude for Durum Fixed Price Contract with AOG by Level of Fixed Price ($/a)

ARAC	HAD FP AOG $8.50/bu	HAD FP AOG $9.00/bu	HAD FP AOG $9.50/bu	HAD FP AOG $10.00/bu	HAD FP AOG $10.50/bu
0	67.38	77.36	87.35	97.33	107.31
0.0049	62.90	72.88	82.86	92.84	102.81
0.0098	58.82	68.79	78.76	88.73	98.70
0.0146	55.06	65.03	74.99	84.96	94.92
0.0195	51.59	61.55	71.51	81.47	91.42
0.0244	48.38	58.33	68.28	78.23	88.18
0.0293	45.40	55.35	65.29	75.23	85.17
0.0341	42.64	52.58	62.52	72.45	82.38
0.0390	40.08	50.01	59.94	69.87	79.79
0.0439	37.69	47.63	57.55	67.47	77.37
0.0488	35.48	45.40	55.32	65.23	75.13
0.0536	33.41	43.33	53.24	63.15	73.04
0.0585	31.48	41.40	51.30	61.20	71.08
0.0634	29.67	39.59	49.49	59.37	69.24
0.0683	27.98	37.88	47.78	57.66	67.52
0.0731	26.38	36.28	46.17	56.05	65.90
0.0780	24.87	34.77	44.66	54.53	64.37
0.0829	23.44	33.34	43.23	53.09	62.92
0.0878	22.09	31.99	41.87	51.72	61.55
0.0926	20.81	30.70	40.58	50.43	60.25
0.0975	19.58	29.48	39.35	49.20	59.01
0.1024	18.41	28.31	38.18	48.02	57.84
0.1073	17.30	27.19	37.06	46.90	56.71
0.1121	16.23	26.12	35.99	45.83	55.63
0.1170	15.21	25.10	34.97	44.81	54.60

Appendix Table B2. Risk Premiums Relative to HRS Hedged by Risk Attitude for Durum Fixed Price Contract with AOG by Level of Fixed Price ($/a)

ARAC	HAD FP AOG $8.50/bu	HAD FP AOG $9.00/bu	HAD FP AOG $9.50/bu	HAD FP AOG $10.00/bu	HAD FP AOG $10.50/bu
0	(12.54)	(2.56)	7.42	17.41	27.39
0.0049	(14.29)	(4.31)	5.66	15.64	25.62
0.0098	(15.88)	(5.90)	4.07	14.04	24.01
0.0146	(17.32)	(7.35)	2.61	12.58	22.54
0.0195	(18.62)	(8.66)	1.30	11.25	21.21
0.0244	(19.79)	(9.84)	0.11	10.06	20.01
0.0293	(20.84)	(10.89)	(0.95)	8.99	18.93
0.0341	(21.77)	(11.83)	(1.90)	8.04	17.97
0.0390	(22.60)	(12.66)	(2.73)	7.19	17.11
0.0439	(23.33)	(13.40)	(3.47)	6.44	16.35
0.0488	(23.97)	(14.04)	(4.12)	5.79	15.68
0.0536	(24.53)	(14.61)	(4.70)	5.20	15.09
0.0585	(25.02)	(15.11)	(5.20)	4.69	14.57
0.0634	(25.46)	(15.55)	(5.65)	4.24	14.11
0.0683	(25.85)	(15.95)	(6.05)	3.83	13.69
0.0731	(26.20)	(16.30)	(6.41)	3.47	13.32
0.0780	(26.52)	(16.62)	(6.73)	3.14	12.98
0.0829	(26.80)	(16.90)	(7.02)	2.84	12.68
0.0878	(27.07)	(17.17)	(7.29)	2.57	12.40
0.0926	(27.31)	(17.41)	(7.54)	2.32	12.14
0.0975	(27.53)	(17.64)	(7.77)	2.08	11.90
0.1024	(27.75)	(17.85)	(7.98)	1.86	11.67
0.1073	(27.95)	(18.05)	(8.18)	1.66	11.46
0.1121	(28.14)	(18.24)	(8.38)	1.46	11.27
0.1170	(28.32)	(18.43)	(8.56)	1.28	11.08

Appendix Table B3. Certainty Equivalents by Risk Attitude for Contract Alternatives, Sensitivity of Level of Fixed Spread

ARAC	HRS Hedged	HAD Fix Price	HAD Fix Spread=0	HAD Fix Spread=1	HAD Fix Spread=2	HAD Fix Spread=3	HAD Fix Spread=4	HAD Fix Spread=5
0	79.92	67.38	27.38	47.38	67.38	87.38	107.38	127.38
0.0049	77.19	62.91	21.11	41.11	61.11	81.11	101.11	121.11
0.0098	74.70	58.82	15.25	35.25	55.25	75.25	95.25	115.25
0.0146	72.38	55.07	9.72	29.72	49.72	69.72	89.72	109.72
0.0195	70.21	51.60	4.48	24.48	44.48	64.48	84.48	104.48
0.0244	68.17	48.39	(0.49)	19.51	39.51	59.51	79.51	99.51
0.0293	66.24	45.41	(5.21)	14.79	34.79	54.79	74.79	94.79
0.0341	64.41	42.65	(9.68)	10.32	30.32	50.32	70.32	90.32
0.0390	62.68	40.10	(13.92)	6.08	26.08	46.08	66.08	86.08
0.0439	61.02	37.72	(17.94)	2.06	22.06	42.06	62.06	82.06
0.0488	59.44	35.50	(21.73)	(1.73)	18.27	38.27	58.27	78.27
0.0536	57.94	33.44	(25.31)	(5.31)	14.69	34.69	54.69	74.69
0.0585	56.51	31.51	(28.69)	(8.69)	11.31	31.31	51.31	71.31
0.0634	55.14	29.71	(31.88)	(11.88)	8.12	28.12	48.12	68.12
0.0683	53.83	28.01	(34.88)	(14.88)	5.12	25.12	45.12	65.12
0.0731	52.58	26.42	(37.72)	(17.72)	2.28	22.28	42.28	62.28
0.0780	51.39	24.91	(40.39)	(20.39)	(0.39)	19.61	39.61	59.61
0.0829	50.25	23.48	(42.91)	(22.91)	(2.91)	17.09	37.09	57.09
0.0878	49.16	22.13	(45.29)	(25.29)	(5.29)	14.71	34.71	54.71
0.0926	48.11	20.84	(47.54)	(27.54)	(7.54)	12.46	32.46	52.46
0.0975	47.12	19.62	(49.68)	(29.68)	(9.68)	10.32	30.32	50.32
0.1024	46.16	18.45	(51.69)	(31.69)	(11.69)	8.31	28.31	48.31
0.1073	45.25	17.34	(53.61)	(33.61)	(13.61)	6.39	26.39	46.39
0.1121	44.37	16.27	(55.42)	(35.42)	(15.42)	4.58	24.58	44.58
0.1170	43.53	15.24	(57.15)	(37.15)	(17.15)	2.85	22.85	42.85

Appendix Table B4. Risk Premiums Relative to HRS Hedged by Risk Attitude for Contract Alternatives, Sensitivity of Fixed Spread

ARAC	HRS Hedged	HAD Fix Price	HAD Fix Spread=0	HAD Fix Spread=1	HAD Fix Spread=2	HAD Fix Spread=3	HAD Fix Spread=4	HAD Fix Spread=5
0	-	(12.54)	(52.54)	(32.54)	(12.54)	7.46	27.46	47.46
0.0049	-	(14.29)	(56.08)	(36.08)	(16.08)	3.92	23.92	43.92
0.0098	-	(15.87)	(59.45)	(39.45)	(19.45)	0.55	20.55	40.55
0.0146	-	(17.31)	(62.66)	(42.66)	(22.66)	(2.66)	17.34	37.34
0.0195	-	(18.61)	(65.73)	(45.73)	(25.73)	(5.73)	14.27	34.27
0.0244	-	(19.78)	(68.66)	(48.66)	(28.66)	(8.66)	11.34	31.34
0.0293	-	(20.83)	(71.45)	(51.45)	(31.45)	(11.45)	8.55	28.55
0.0341	-	(21.76)	(74.10)	(54.10)	(34.10)	(14.10)	5.90	25.90
0.0390	-	(22.58)	(76.60)	(56.60)	(36.60)	(16.60)	3.40	23.40
0.0439	-	(23.30)	(78.96)	(58.96)	(38.96)	(18.96)	1.04	21.04
0.0488	-	(23.94)	(81.17)	(61.17)	(41.17)	(21.17)	(1.17)	18.83
0.0536	-	(24.50)	(83.25)	(63.25)	(43.25)	(23.25)	(3.25)	16.75
0.0585	-	(24.99)	(85.20)	(65.20)	(45.20)	(25.20)	(5.20)	14.80
0.0634	-	(25.43)	(87.02)	(67.02)	(47.02)	(27.02)	(7.02)	12.98
0.0683	-	(25.82)	(88.71)	(68.71)	(48.71)	(28.71)	(8.71)	11.29
0.0731	-	(26.17)	(90.30)	(70.30)	(50.30)	(30.30)	(10.30)	9.70
0.0780	-	(26.48)	(91.78)	(71.78)	(51.78)	(31.78)	(11.78)	8.22
0.0829	-	(26.76)	(93.16)	(73.16)	(53.16)	(33.16)	(13.16)	6.84
0.0878	-	(27.03)	(94.45)	(74.45)	(54.45)	(34.45)	(14.45)	5.55
0.0926	-	(27.27)	(95.66)	(75.66)	(55.66)	(35.66)	(15.66)	4.34
0.0975	-	(27.50)	(96.79)	(76.79)	(56.79)	(36.79)	(16.79)	3.21
0.1024	-	(27.71)	(97.85)	(77.85)	(57.85)	(37.85)	(17.85)	2.15
0.1073	-	(27.91)	(98.85)	(78.85)	(58.85)	(38.85)	(18.85)	1.15
0.1121	-	(28.10)	(99.79)	(79.79)	(59.79)	(39.79)	(19.79)	0.21
0.1170	-	(28.28)	(100.67)	(80.67)	(60.67)	(40.67)	(20.67)	(0.67)

Appendix Table B5. Certainty Equivalents by Risk Attitude for Contract Alternatives, Lower Durum Discounts and Variability

ARAC	HRS Unpriced	HAD Unpriced	HRS Hedged	HAD Fix Price	HAD Fix Spread	HAD Min 8.0	HAD Min 8.50	HAD Min/Max	HAD FP AOG
0	79.92	81.42	79.92	86.11	86.11	87.50	90.30	82.84	86.11
0.0049	73.83	72.52	77.19	83.41	81.66	79.63	82.79	79.40	83.42
0.0098	68.16	66.14	74.70	81.01	77.53	74.10	77.51	76.41	81.02
0.0146	62.85	61.21	72.38	78.83	73.63	69.86	73.48	73.76	78.83
0.0195	57.83	57.16	70.21	76.81	69.92	66.42	70.19	71.36	76.82
0.0244	53.09	53.71	68.17	74.92	66.35	63.50	67.40	69.18	74.93
0.0293	48.59	50.69	66.24	73.14	62.90	60.94	64.95	67.15	73.15
0.0341	44.34	48.00	64.41	71.44	59.54	58.66	62.77	65.27	71.46
0.0390	40.31	45.57	62.68	69.82	56.27	56.59	60.77	63.51	69.85
0.0439	36.51	43.34	61.02	68.27	53.07	54.69	58.94	61.85	68.31
0.0488	32.93	41.28	59.44	66.78	49.92	52.93	57.23	60.28	66.83
0.0536	29.57	39.37	57.94	65.34	46.84	51.28	55.63	58.79	65.41
0.0585	26.40	37.59	56.51	63.96	43.81	49.73	54.13	57.37	64.04
0.0634	23.43	35.92	55.14	62.63	40.83	48.27	52.70	56.03	62.73
0.0683	20.65	34.34	53.83	61.34	37.90	46.89	51.35	54.74	61.46
0.0731	18.04	32.86	52.58	60.10	35.03	45.57	50.07	53.51	60.25
0.0780	15.60	31.45	51.39	58.90	32.23	44.32	48.85	52.33	59.07
0.0829	13.31	30.12	50.25	57.74	29.49	43.13	47.68	51.21	57.95
0.0878	11.17	28.86	49.16	56.63	26.82	41.99	46.57	50.13	56.86
0.0926	9.16	27.66	48.11	55.55	24.23	40.91	45.51	49.10	55.82
0.0975	7.27	26.51	47.12	54.51	21.73	39.87	44.49	48.11	54.82
0.1024	5.49	25.42	46.16	53.50	19.31	38.88	43.52	47.16	53.86
0.1073	3.81	24.38	45.25	52.53	16.99	37.92	42.58	46.25	52.94
0.1121	2.23	23.39	44.37	51.59	14.76	37.01	41.69	45.38	52.05
0.1170	0.74	22.44	43.53	50.68	12.63	36.14	40.83	44.54	51.19

Appendix Table B6. Certainty Equivalents by Risk Attitude for Contract Alternatives, Higher Levels for Durum Discounts

ARAC	HRS Unpriced	HAD Unpriced	HRS Hedged	HAD Fix Price	HAD Fix Spread	HAD Min 8.0	HAD Min 8.50	HAD Min/Max	HAD FP AOG
0	79.92	57.44	79.92	62.13	62.13	63.51	66.32	58.85	62.13
0.0049	73.83	45.74	77.19	57.26	55.51	52.96	56.16	53.10	57.26
0.0098	68.16	37.11	74.70	52.90	49.42	45.22	48.70	48.05	52.89
0.0146	62.85	30.32	72.38	48.96	43.78	39.14	42.82	43.58	48.96
0.0195	57.83	24.77	70.21	45.41	38.53	34.14	37.97	39.61	45.41
0.0244	53.09	20.10	68.17	42.20	33.63	29.91	33.86	36.07	42.19
0.0293	48.59	16.11	66.24	39.30	29.03	26.27	30.31	32.91	39.28
0.0341	44.34	12.65	64.41	36.65	24.69	23.09	27.19	30.07	36.63
0.0390	40.31	9.63	62.68	34.25	20.60	20.28	24.43	27.51	34.22
0.0439	36.51	6.95	61.02	32.05	16.71	17.77	21.96	25.18	32.02
0.0488	32.93	4.57	59.44	30.03	13.01	15.51	19.73	23.06	29.99
0.0536	29.57	2.43	57.94	28.16	9.48	13.46	17.71	21.12	28.13
0.0585	26.40	0.50	56.51	26.43	6.10	11.59	15.86	19.34	26.40
0.0634	23.43	(1.26)	55.14	24.83	2.87	9.88	14.15	17.68	24.78
0.0683	20.65	(2.87)	53.83	23.33	(0.22)	8.30	12.58	16.15	23.28
0.0731	18.04	(4.34)	52.58	21.92	(3.19)	6.83	11.11	14.71	21.87
0.0780	15.60	(5.70)	51.39	20.59	(6.03)	5.45	9.74	13.36	20.54
0.0829	13.31	(6.96)	50.25	19.33	(8.75)	4.17	8.45	12.09	19.28
0.0878	11.17	(8.13)	49.16	18.14	(11.35)	2.96	7.24	10.89	18.08
0.0926	9.16	(9.23)	48.11	17.01	(13.85)	1.81	6.09	9.76	16.95
0.0975	7.27	(10.25)	47.12	15.92	(16.23)	0.73	5.00	8.67	15.86
0.1024	5.49	(11.22)	46.16	14.89	(18.50)	(0.30)	3.96	7.64	14.83
0.1073	3.81	(12.12)	45.25	13.89	(20.66)	(1.28)	2.97	6.65	13.83
0.1121	2.23	(12.98)	44.37	12.94	(22.73)	(2.22)	2.02	5.71	12.88
0.1170	0.74	(13.79)	43.53	12.02	(24.70)	(3.12)	1.11	4.80	11.96

Appendix Table B7. Risk Premiums Relative to HRS Hedged by Risk Attitude for Contract Alternatives, Lower Levels and Variability for Durum Discounts

ARAC	HRS Unpriced	HAD Unpriced	HRS Hedged	HAD Fix Price	HAD Fix Spread	HAD Min 8.0	HAD Min 8.50	HAD Min/Max	HAD FP AOG
0	0.00	1.50	-	6.19	6.19	7.57	10.38	2.92	6.19
0.0049	(3.36)	(4.68)	-	6.22	4.47	2.43	5.59	2.20	6.22
0.0098	(6.53)	(8.55)	-	6.32	2.83	(0.60)	2.82	1.71	6.32
0.0146	(9.53)	(11.17)	-	6.45	1.25	(2.52)	1.10	1.38	6.46
0.0195	(12.38)	(13.05)	-	6.60	(0.29)	(3.79)	(0.02)	1.15	6.61
0.0244	(15.08)	(14.46)	-	6.75	(1.82)	(4.67)	(0.77)	1.01	6.76
0.0293	(17.65)	(15.55)	-	6.89	(3.34)	(5.30)	(1.29)	0.91	6.91
0.0341	(20.08)	(16.41)	-	7.03	(4.87)	(5.75)	(1.65)	0.86	7.05
0.0390	(22.36)	(17.11)	-	7.15	(6.41)	(6.08)	(1.90)	0.83	7.17
0.0439	(24.51)	(17.68)	-	7.25	(7.96)	(6.33)	(2.09)	0.83	7.29
0.0488	(26.51)	(18.16)	-	7.33	(9.52)	(6.52)	(2.22)	0.83	7.38
0.0536	(28.38)	(18.57)	-	7.40	(11.10)	(6.66)	(2.31)	0.85	7.47
0.0585	(30.11)	(18.92)	-	7.45	(12.70)	(6.78)	(2.38)	0.87	7.53
0.0634	(31.70)	(19.22)	-	7.49	(14.31)	(6.87)	(2.43)	0.89	7.59
0.0683	(33.18)	(19.49)	-	7.51	(15.93)	(6.94)	(2.48)	0.91	7.63
0.0731	(34.54)	(19.72)	-	7.52	(17.55)	(7.01)	(2.51)	0.93	7.66
0.0780	(35.78)	(19.93)	-	7.51	(19.16)	(7.07)	(2.54)	0.95	7.69
0.0829	(36.93)	(20.13)	-	7.50	(20.76)	(7.12)	(2.56)	0.96	7.70
0.0878	(37.99)	(20.30)	-	7.47	(22.34)	(7.16)	(2.58)	0.97	7.71
0.0926	(38.96)	(20.46)	-	7.43	(23.88)	(7.21)	(2.61)	0.98	7.71
0.0975	(39.85)	(20.60)	-	7.39	(25.39)	(7.25)	(2.63)	0.99	7.71
0.1024	(40.67)	(20.74)	-	7.34	(26.85)	(7.28)	(2.65)	1.00	7.70
0.1073	(41.43)	(20.86)	-	7.28	(28.25)	(7.32)	(2.66)	1.01	7.69
0.1121	(42.13)	(20.98)	-	7.22	(29.60)	(7.36)	(2.68)	1.01	7.68
0.1170	(42.78)	(21.08)	-	7.15	(30.89)	(7.39)	(2.70)	1.01	7.67

Appendix Table B8. Risk Premiums Relative to HRS Hedged by Risk Attitude for Contract Alternatives, Higher Levels of Durum Discounts

ARAC	HRS Unpriced	HAD Unpriced	HRS Hedged	HAD Fix Price	HAD Fix Spread	HAD Min 8.0	HAD Min 8.50	HAD Min/Max	HAD FP AOG
0	0.00	(22.49)	-	(17.79)	(17.79)	(16.41)	(13.60)	(21.07)	(17.79)
0.0049	(3.36)	(31.46)	-	(19.93)	(21.68)	(24.24)	(21.04)	(24.09)	(19.94)
0.0098	(6.53)	(37.59)	-	(21.80)	(25.27)	(29.47)	(26.00)	(26.65)	(21.80)
0.0146	(9.53)	(42.06)	-	(23.41)	(28.60)	(33.24)	(29.56)	(28.80)	(23.42)
0.0195	(12.38)	(45.44)	-	(24.80)	(31.68)	(36.07)	(32.24)	(30.60)	(24.80)
0.0244	(15.08)	(48.07)	-	(25.97)	(34.54)	(38.26)	(34.31)	(32.10)	(25.98)
0.0293	(17.65)	(50.13)	-	(26.95)	(37.21)	(39.97)	(35.93)	(33.33)	(26.96)
0.0341	(20.08)	(51.76)	-	(27.76)	(39.72)	(41.32)	(37.22)	(34.34)	(27.78)
0.0390	(22.36)	(53.05)	-	(28.43)	(42.08)	(42.40)	(38.24)	(35.17)	(28.45)
0.0439	(24.51)	(54.07)	-	(28.97)	(44.31)	(43.25)	(39.06)	(35.84)	(29.00)
0.0488	(26.51)	(54.88)	-	(29.42)	(46.44)	(43.94)	(39.71)	(36.38)	(29.45)
0.0536	(28.38)	(55.51)	-	(29.78)	(48.46)	(44.48)	(40.23)	(36.82)	(29.82)
0.0585	(30.11)	(56.01)	-	(30.07)	(50.40)	(44.91)	(40.65)	(37.17)	(30.11)
0.0634	(31.70)	(56.40)	-	(30.31)	(52.26)	(45.26)	(40.98)	(37.45)	(30.35)
0.0683	(33.18)	(56.70)	-	(30.50)	(54.05)	(45.53)	(41.25)	(37.68)	(30.55)
0.0731	(34.54)	(56.92)	-	(30.66)	(55.77)	(45.76)	(41.47)	(37.87)	(30.71)
0.0780	(35.78)	(57.09)	-	(30.80)	(57.42)	(45.93)	(41.65)	(38.03)	(30.85)
0.0829	(36.93)	(57.21)	-	(30.92)	(59.00)	(46.08)	(41.80)	(38.15)	(30.97)
0.0878	(37.99)	(57.29)	-	(31.02)	(60.51)	(46.20)	(41.92)	(38.26)	(31.07)
0.0926	(38.96)	(57.34)	-	(31.11)	(61.96)	(46.30)	(42.03)	(38.36)	(31.17)
0.0975	(39.85)	(57.37)	-	(31.19)	(63.34)	(46.39)	(42.12)	(38.44)	(31.25)
0.1024	(40.67)	(57.38)	-	(31.27)	(64.66)	(46.46)	(42.20)	(38.52)	(31.33)
0.1073	(41.43)	(57.37)	-	(31.35)	(65.91)	(46.53)	(42.28)	(38.59)	(31.41)
0.1121	(42.13)	(57.35)	-	(31.43)	(67.10)	(46.59)	(42.35)	(38.66)	(31.49)
0.1170	(42.78)	(57.32)	-	(31.51)	(68.22)	(46.64)	(42.42)	(38.73)	(31.57)

Appendix Table B9. Certainty Equivalents by Risk Attitude for Contract Alternatives, 10 bushels per acre Contracted

ARAC	HRS Unpriced	HAD Unpriced	HRS Hedged	HAD Fix Price	HAD Fix Spread	HAD Min 8.0	HAD Min 8.50	HAD Min/Max	HAD FP AOG
0	79.92	62.69	79.92	65.03	65.03	65.73	67.13	63.40	65.03
0.0049	73.83	51.53	75.96	57.90	57.46	55.17	56.79	55.60	57.90
0.0098	68.16	43.23	72.33	51.99	51.11	47.35	49.13	49.21	51.99
0.0146	62.85	36.61	68.97	46.93	45.61	41.13	43.03	43.80	46.93
0.0195	57.83	31.11	65.84	42.51	40.75	35.95	37.94	39.12	42.51
0.0244	53.09	26.40	62.90	38.59	36.39	31.51	33.57	35.01	38.59
0.0293	48.59	22.31	60.14	35.08	32.44	27.63	29.75	31.35	35.08
0.0341	44.34	18.70	57.54	31.93	28.85	24.20	26.37	28.08	31.93
0.0390	40.31	15.50	55.08	29.07	25.55	21.15	23.35	25.14	29.07
0.0439	36.51	12.64	52.75	26.48	22.52	18.40	20.62	22.47	26.48
0.0488	32.93	10.06	50.54	24.11	19.71	15.91	18.16	20.05	24.11
0.0536	29.57	7.73	48.45	21.95	17.11	13.65	15.92	17.84	21.95
0.0585	26.40	5.61	46.46	19.96	14.70	11.59	13.87	15.82	19.96
0.0634	23.43	3.68	44.58	18.13	12.44	9.70	11.99	13.95	18.13
0.0683	20.65	1.90	42.78	16.43	10.33	7.96	10.25	12.23	16.43
0.0731	18.04	0.27	41.08	14.86	8.34	6.35	8.65	10.64	14.86
0.0780	15.60	(1.24)	39.46	13.40	6.48	4.86	7.16	9.16	13.40
0.0829	13.31	(2.64)	37.91	12.03	4.72	3.47	5.77	7.77	12.03
0.0878	11.17	(3.94)	36.44	10.75	3.06	2.17	4.47	6.48	10.75
0.0926	9.16	(5.16)	35.04	9.55	1.48	0.95	3.26	5.27	9.55
0.0975	7.27	(6.30)	33.71	8.42	(0.01)	(0.19)	2.11	4.13	8.42
0.1024	5.49	(7.36)	32.44	7.36	(1.43)	(1.26)	1.04	3.05	7.36
0.1073	3.81	(8.37)	31.22	6.35	(2.78)	(2.28)	0.02	2.03	6.35
0.1121	2.23	(9.32)	30.07	5.39	(4.06)	(3.24)	(0.95)	1.07	5.39
0.1170	0.74	(10.21)	28.96	4.48	(5.28)	(4.15)	(1.86)	0.15	4.48

Appendix Table B10. Certainty Equivalents by Risk Attitude for Contract Alternatives, 15 bushels per acre Contracted

ARAC	HRS Unpriced	HAD Unpriced	HRS Hedged	HAD Fix Price	HAD Fix Spread	HAD Min 8.0	HAD Min 8.50	HAD Min/Max	HAD FP AOG
0	79.92	62.69	79.92	66.21	66.21	67.24	69.35	63.75	66.21
0.0049	73.83	51.53	76.69	60.59	59.59	56.96	59.37	57.31	60.59
0.0098	68.16	43.23	73.74	55.70	53.70	49.36	51.99	51.80	55.69
0.0146	62.85	36.61	71.02	51.35	48.35	43.31	46.11	46.97	51.34
0.0195	57.83	31.11	68.48	47.44	43.45	38.26	41.19	42.70	47.43
0.0244	53.09	26.40	66.11	43.90	38.92	33.92	36.96	38.87	43.89
0.0293	48.59	22.31	63.89	40.68	34.71	30.13	33.25	35.43	40.67
0.0341	44.34	18.70	61.79	37.74	30.78	26.77	29.94	32.32	37.73
0.0390	40.31	15.50	59.82	35.05	27.12	23.75	26.98	29.49	35.04
0.0439	36.51	12.64	57.95	32.58	23.69	21.04	24.30	26.91	32.57
0.0488	32.93	10.06	56.18	30.30	20.48	18.58	21.86	24.55	30.29
0.0536	29.57	7.73	54.51	28.20	17.48	16.33	19.64	22.38	28.20
0.0585	26.40	5.61	52.92	26.26	14.65	14.28	17.60	20.38	26.25
0.0634	23.43	3.68	51.41	24.46	11.99	12.38	15.71	18.52	24.45
0.0683	20.65	1.90	49.97	22.78	9.50	10.64	13.97	16.80	22.77
0.0731	18.04	0.27	48.61	21.21	7.14	9.02	12.35	15.20	21.21
0.0780	15.60	(1.24)	47.31	19.75	4.93	7.51	10.84	13.70	19.74
0.0829	13.31	(2.64)	46.07	18.37	2.83	6.10	9.43	12.30	18.36
0.0878	11.17	(3.94)	44.89	17.07	0.86	4.78	8.10	10.98	17.06
0.0926	9.16	(5.16)	43.77	15.85	(1.01)	3.55	6.86	9.73	15.84
0.0975	7.27	(6.30)	42.70	14.69	(2.78)	2.38	5.68	8.56	14.68
0.1024	5.49	(7.36)	41.67	13.59	(4.46)	1.28	4.57	7.44	13.58
0.1073	3.81	(8.37)	40.69	12.54	(6.05)	0.24	3.51	6.38	12.54
0.1121	2.23	(9.32)	39.75	11.54	(7.56)	(0.75)	2.51	5.37	11.54
0.1170	0.74	(10.21)	38.85	10.59	(9.00)	(1.69)	1.55	4.41	10.59

Appendix Table B11. Certainty Equivalents by Risk Attitude for Contract Alternatives, 25 bushels per acre Contracted

ARAC	HRS Unpriced	HAD Unpriced	HRS Hedged	HAD Fix Price	HAD Fix Spread	HAD Min 8.0	HAD Min 8.50	HAD Min/Max	HAD FP AOG
0	79.92	62.69	79.92	68.55	68.56	70.28	73.79	64.46	68.53
0.0049	73.83	51.53	77.47	64.80	61.99	60.49	64.46	59.97	64.77
0.0098	68.16	43.23	75.20	61.23	55.62	53.26	57.55	55.82	61.21
0.0146	62.85	36.61	73.06	57.84	49.45	47.49	52.02	51.99	57.82
0.0195	57.83	31.11	71.02	54.62	43.46	42.65	47.37	48.43	54.61
0.0244	53.09	26.40	69.06	51.57	37.68	38.48	43.34	45.14	51.56
0.0293	48.59	22.31	67.18	48.68	32.10	34.80	39.76	42.09	48.69
0.0341	44.34	18.70	65.36	45.95	26.74	31.51	36.55	39.26	45.97
0.0390	40.31	15.50	63.59	43.37	21.60	28.54	33.64	36.63	43.41
0.0439	36.51	12.64	61.87	40.94	16.69	25.85	30.98	34.18	41.00
0.0488	32.93	10.06	60.19	38.63	11.99	23.38	28.53	31.90	38.72
0.0536	29.57	7.73	58.56	36.45	7.50	21.12	26.28	29.76	36.57
0.0585	26.40	5.61	56.98	34.38	3.22	19.03	24.19	27.77	34.54
0.0634	23.43	3.68	55.43	32.41	(0.88)	17.09	22.23	25.89	32.62
0.0683	20.65	1.90	53.92	30.54	(4.81)	15.28	20.41	24.12	30.80
0.0731	18.04	0.27	52.46	28.75	(8.57)	13.60	18.70	22.45	29.07
0.0780	15.60	(1.24)	51.03	27.05	(12.18)	12.02	17.08	20.87	27.43
0.0829	13.31	(2.64)	49.64	25.42	(15.63)	10.53	15.56	19.36	25.87
0.0878	11.17	(3.94)	48.30	23.86	(18.94)	9.13	14.11	17.93	24.37
0.0926	9.16	(5.16)	46.99	22.37	(22.11)	7.80	12.74	16.56	22.95
0.0975	7.27	(6.30)	45.71	20.93	(25.14)	6.55	11.43	15.25	21.59
0.1024	5.49	(7.36)	44.48	19.56	(28.03)	5.35	10.19	14.00	20.29
0.1073	3.81	(8.37)	43.28	18.24	(30.79)	4.21	8.99	12.80	19.05
0.1121	2.23	(9.32)	42.12	16.96	(33.41)	3.13	7.85	11.64	17.86
0.1170	0.74	(10.21)	40.99	15.74	(35.91)	2.09	6.75	10.53	16.72

Appendix Table B12. Certainty Equivalents by Risk Attitude for Contract Alternatives, 28.5 bushels per acre Contracted

ARAC	HRS Unpriced	HAD Unpriced	HRS Hedged	HAD Fix Price	HAD Fix Spread	HAD Min 8.0	HAD Min 8.50	HAD Min/Max	HAD FP AOG
0	79.92	62.69	79.92	69.38	69.38	71.35	75.34	64.71	69.16
0.0049	73.83	51.53	77.53	65.84	62.19	61.71	66.21	60.61	65.63
0.0098	68.16	43.23	75.28	62.39	55.09	54.59	59.44	56.76	62.22
0.0146	62.85	36.61	73.12	59.01	48.08	48.90	54.01	53.12	58.93
0.0195	57.83	31.11	71.03	55.72	41.18	44.12	49.43	49.70	55.75
0.0244	53.09	26.40	68.99	52.50	34.42	39.99	45.44	46.48	52.72
0.0293	48.59	22.31	66.99	49.37	27.81	36.33	41.89	43.46	49.81
0.0341	44.34	18.70	65.01	46.30	21.37	33.05	38.69	40.62	47.05
0.0390	40.31	15.50	63.05	43.30	15.12	30.09	35.77	37.95	44.43
0.0439	36.51	12.64	61.11	40.37	9.05	27.38	33.10	35.44	41.94
0.0488	32.93	10.06	59.18	37.50	3.18	24.90	30.63	33.08	39.58
0.0536	29.57	7.73	57.27	34.69	(2.51)	22.62	28.35	30.85	37.34
0.0585	26.40	5.61	55.37	31.94	(8.00)	20.50	26.22	28.74	35.22
0.0634	23.43	3.68	53.50	29.24	(13.30)	18.53	24.22	26.75	33.21
0.0683	20.65	1.90	51.64	26.60	(18.38)	16.69	22.35	24.85	31.31
0.0731	18.04	0.27	49.82	24.03	(23.23)	14.97	20.58	23.04	29.50
0.0780	15.60	(1.24)	48.02	21.52	(27.84)	13.35	18.92	21.32	27.78
0.0829	13.31	(2.64)	46.26	19.08	(32.21)	11.83	17.33	19.67	26.15
0.0878	11.17	(3.94)	44.53	16.72	(36.32)	10.38	15.83	18.10	24.60
0.0926	9.16	(5.16)	42.85	14.44	(40.19)	9.02	14.40	16.59	23.12
0.0975	7.27	(6.30)	41.21	12.24	(43.81)	7.72	13.03	15.14	21.71
0.1024	5.49	(7.36)	39.61	10.13	(47.19)	6.48	11.72	13.74	20.36
0.1073	3.81	(8.37)	38.06	8.11	(50.35)	5.30	10.46	12.40	19.08
0.1121	2.23	(9.32)	36.57	6.16	(53.30)	4.18	9.26	11.12	17.85
0.1170	0.74	(10.21)	35.12	4.31	(56.06)	3.10	8.11	9.88	16.68

Appendix Table B13. Risk Premiums Relative to HRS Hedged by Risk Attitude for Contract Alternatives, 10 bushels per acre Contracted

ARAC	HRS Unpriced	HAD Unpriced	HRS Hedged	HAD Fix Price	HAD Fix Spread	HAD Min 8.0	HAD Min 8.50	HAD Min/Max	HAD FP AOG
0	0.00	(17.24)	-	(14.89)	(14.89)	(14.20)	(12.79)	(16.53)	(14.89)
0.0049	(2.13)	(24.43)	-	(18.06)	(18.51)	(20.79)	(19.18)	(20.36)	(18.06)
0.0098	(4.17)	(29.11)	-	(20.34)	(21.22)	(24.98)	(23.21)	(23.12)	(20.34)
0.0146	(6.13)	(32.36)	-	(22.04)	(23.36)	(27.84)	(25.94)	(25.17)	(22.04)
0.0195	(8.01)	(34.73)	-	(23.33)	(25.09)	(29.89)	(27.90)	(26.72)	(23.33)
0.0244	(9.82)	(36.50)	-	(24.31)	(26.51)	(31.39)	(29.33)	(27.90)	(24.31)
0.0293	(11.55)	(37.84)	-	(25.06)	(27.70)	(32.51)	(30.39)	(28.79)	(25.06)
0.0341	(13.20)	(38.84)	-	(25.61)	(28.69)	(33.33)	(31.17)	(29.46)	(25.61)
0.0390	(14.76)	(39.58)	-	(26.00)	(29.53)	(33.93)	(31.73)	(29.94)	(26.00)
0.0439	(16.23)	(40.11)	-	(26.27)	(30.23)	(34.35)	(32.12)	(30.28)	(26.27)
0.0488	(17.61)	(40.48)	-	(26.43)	(30.83)	(34.63)	(32.38)	(30.49)	(26.43)
0.0536	(18.88)	(40.72)	-	(26.50)	(31.34)	(34.80)	(32.53)	(30.61)	(26.50)
0.0585	(20.06)	(40.85)	-	(26.50)	(31.77)	(34.87)	(32.59)	(30.65)	(26.50)
0.0634	(21.14)	(40.90)	-	(26.45)	(32.14)	(34.88)	(32.59)	(30.62)	(26.45)
0.0683	(22.13)	(40.88)	-	(26.35)	(32.46)	(34.82)	(32.53)	(30.55)	(26.35)
0.0731	(23.03)	(40.81)	-	(26.22)	(32.73)	(34.73)	(32.43)	(30.44)	(26.22)
0.0780	(23.85)	(40.69)	-	(26.06)	(32.98)	(34.60)	(32.30)	(30.30)	(26.06)
0.0829	(24.60)	(40.55)	-	(25.88)	(33.19)	(34.45)	(32.14)	(30.14)	(25.88)
0.0878	(25.27)	(40.38)	-	(25.69)	(33.39)	(34.27)	(31.97)	(29.96)	(25.69)
0.0926	(25.89)	(40.20)	-	(25.49)	(33.56)	(34.09)	(31.79)	(29.78)	(25.49)
0.0975	(26.44)	(40.00)	-	(25.29)	(33.72)	(33.90)	(31.60)	(29.58)	(25.29)
0.1024	(26.95)	(39.80)	-	(25.08)	(33.87)	(33.70)	(31.40)	(29.39)	(25.08)
0.1073	(27.41)	(39.59)	-	(24.88)	(34.00)	(33.50)	(31.21)	(29.19)	(24.88)
0.1121	(27.83)	(39.38)	-	(24.68)	(34.13)	(33.30)	(31.01)	(29.00)	(24.68)
0.1170	(28.22)	(39.17)	-	(24.48)	(34.25)	(33.11)	(30.82)	(28.81)	(24.48)

Appendix Table B14. Risk Premiums Relative to HRS Hedged by Risk Attitude for Contract Alternatives, 15 bushels per acre Contracted

ARAC	HRS Unpriced	HAD Unpriced	HRS Hedged	HAD Fix Price	HAD Fix Spread	HAD Min 8.0	HAD Min 8.50	HAD Min/Max	HAD FP AOG
0	0.00	(17.24)	-	(13.71)	(13.71)	(12.68)	(10.57)	(16.17)	(13.72)
0.0049	(2.86)	(25.16)	-	(16.10)	(17.10)	(19.73)	(17.32)	(19.38)	(16.10)
0.0098	(5.58)	(30.51)	-	(18.04)	(20.05)	(24.38)	(21.75)	(21.95)	(18.05)
0.0146	(8.17)	(34.41)	-	(19.67)	(22.66)	(27.71)	(24.91)	(24.05)	(19.67)
0.0195	(10.65)	(37.38)	-	(21.04)	(25.03)	(30.22)	(27.29)	(25.79)	(21.05)
0.0244	(13.03)	(39.71)	-	(22.21)	(27.20)	(32.19)	(29.15)	(27.24)	(22.22)
0.0293	(15.30)	(41.58)	-	(23.21)	(29.18)	(33.76)	(30.64)	(28.46)	(23.22)
0.0341	(17.46)	(43.09)	-	(24.06)	(31.01)	(35.03)	(31.85)	(29.47)	(24.06)
0.0390	(19.50)	(44.32)	-	(24.77)	(32.70)	(36.06)	(32.84)	(30.33)	(24.78)
0.0439	(21.44)	(45.31)	-	(25.37)	(34.26)	(36.91)	(33.65)	(31.04)	(25.38)
0.0488	(23.25)	(46.12)	-	(25.88)	(35.70)	(37.61)	(34.32)	(31.63)	(25.89)
0.0536	(24.94)	(46.77)	-	(26.30)	(37.03)	(38.17)	(34.87)	(32.13)	(26.31)
0.0585	(26.51)	(47.30)	-	(26.65)	(38.27)	(38.64)	(35.32)	(32.54)	(26.66)
0.0634	(27.97)	(47.73)	-	(26.95)	(39.41)	(39.02)	(35.69)	(32.88)	(26.95)
0.0683	(29.32)	(48.07)	-	(27.19)	(40.48)	(39.34)	(36.00)	(33.17)	(27.20)
0.0731	(30.56)	(48.34)	-	(27.39)	(41.46)	(39.59)	(36.26)	(33.41)	(27.40)
0.0780	(31.71)	(48.55)	-	(27.56)	(42.38)	(39.80)	(36.47)	(33.61)	(27.57)
0.0829	(32.76)	(48.71)	-	(27.70)	(43.24)	(39.97)	(36.64)	(33.77)	(27.71)
0.0878	(33.72)	(48.84)	-	(27.82)	(44.04)	(40.11)	(36.79)	(33.92)	(27.83)
0.0926	(34.61)	(48.93)	-	(27.92)	(44.78)	(40.22)	(36.91)	(34.04)	(27.93)
0.0975	(35.43)	(48.99)	-	(28.01)	(45.48)	(40.32)	(37.02)	(34.14)	(28.01)
0.1024	(36.18)	(49.03)	-	(28.08)	(46.13)	(40.39)	(37.10)	(34.23)	(28.09)
0.1073	(36.88)	(49.06)	-	(28.15)	(46.74)	(40.45)	(37.18)	(34.31)	(28.15)
0.1121	(37.52)	(49.07)	-	(28.21)	(47.32)	(40.51)	(37.24)	(34.38)	(28.21)
0.1170	(38.11)	(49.07)	-	(28.26)	(47.85)	(40.55)	(37.30)	(34.45)	(28.26)

Appendix Table B15. Risk Premiums Relative to HRS Hedged by Risk Attitude for Contract Alternatives, 25 bushels per acre Contracted

ARAC	HRS Unpriced	HAD Unpriced	HRS Hedged	HAD Fix Price	HAD Fix Spread	HAD Min 8.0	HAD Min 8.50	HAD Min/Max	HAD FP AOG
0	0.00	(17.23)	-	(11.37)	(11.36)	(9.64)	(6.13)	(15.46)	(11.39)
0.0049	(3.64)	(25.94)	-	(12.68)	(15.48)	(16.98)	(13.01)	(17.50)	(12.70)
0.0098	(7.03)	(31.97)	-	(13.97)	(19.57)	(21.94)	(17.65)	(19.38)	(13.99)
0.0146	(10.21)	(36.45)	-	(15.22)	(23.61)	(25.57)	(21.03)	(21.07)	(15.24)
0.0195	(13.19)	(39.91)	-	(16.40)	(27.55)	(28.36)	(23.64)	(22.58)	(16.41)
0.0244	(15.98)	(42.66)	-	(17.49)	(31.38)	(30.59)	(25.73)	(23.92)	(17.50)
0.0293	(18.59)	(44.87)	-	(18.50)	(35.08)	(32.38)	(27.42)	(25.09)	(18.49)
0.0341	(21.02)	(46.66)	-	(19.40)	(38.62)	(33.85)	(28.81)	(26.10)	(19.39)
0.0390	(23.27)	(48.09)	-	(20.21)	(41.99)	(35.05)	(29.95)	(26.96)	(20.18)
0.0439	(25.35)	(49.23)	-	(20.93)	(45.18)	(36.02)	(30.89)	(27.69)	(20.87)
0.0488	(27.26)	(50.13)	-	(21.57)	(48.20)	(36.81)	(31.66)	(28.30)	(21.47)
0.0536	(29.00)	(50.83)	-	(22.12)	(51.06)	(37.45)	(32.29)	(28.80)	(21.99)
0.0585	(30.57)	(51.36)	-	(22.60)	(53.76)	(37.95)	(32.79)	(29.21)	(22.43)
0.0634	(32.00)	(51.75)	-	(23.02)	(56.31)	(38.34)	(33.19)	(29.54)	(22.81)
0.0683	(33.27)	(52.02)	-	(23.39)	(58.73)	(38.64)	(33.51)	(29.80)	(23.12)
0.0731	(34.41)	(52.19)	-	(23.70)	(61.03)	(38.86)	(33.76)	(30.01)	(23.39)
0.0780	(35.43)	(52.27)	-	(23.98)	(63.21)	(39.01)	(33.95)	(30.16)	(23.60)
0.0829	(36.33)	(52.28)	-	(24.22)	(65.28)	(39.11)	(34.08)	(30.28)	(23.78)
0.0878	(37.13)	(52.24)	-	(24.43)	(67.24)	(39.17)	(34.18)	(30.37)	(23.92)
0.0926	(37.83)	(52.14)	-	(24.62)	(69.10)	(39.18)	(34.24)	(30.43)	(24.03)
0.0975	(38.45)	(52.01)	-	(24.78)	(70.86)	(39.17)	(34.28)	(30.46)	(24.12)
0.1024	(38.99)	(51.84)	-	(24.92)	(72.51)	(39.13)	(34.29)	(30.48)	(24.19)
0.1073	(39.47)	(51.65)	-	(25.05)	(74.07)	(39.07)	(34.29)	(30.49)	(24.23)
0.1121	(39.88)	(51.44)	-	(25.15)	(75.53)	(38.99)	(34.27)	(30.48)	(24.26)
0.1170	(40.25)	(51.20)	-	(25.25)	(76.90)	(38.90)	(34.24)	(30.46)	(24.27)

Appendix Table B16. Risk Premiums Relative to HRS Hedged by Risk Attitude for Contract Alternatives, 28.5 bushels per acre Contracted

ARAC	HRS Unpriced	HAD Unpriced	HRS Hedged	HAD Fix Price	HAD Fix Spread	HAD Min 8.0	HAD Min 8.50	HAD Min/Max	HAD FP AOG
0	0.00	(17.23)	-	(10.54)	(10.54)	(8.57)	(4.58)	(15.21)	(10.76)
0.0049	(3.70)	(26.00)	-	(11.69)	(15.34)	(15.82)	(11.32)	(16.92)	(11.90)
0.0098	(7.12)	(32.05)	-	(12.89)	(20.19)	(20.69)	(15.84)	(18.52)	(13.06)
0.0146	(10.28)	(36.51)	-	(14.11)	(25.04)	(24.23)	(19.11)	(20.00)	(14.20)
0.0195	(13.20)	(39.93)	-	(15.31)	(29.85)	(26.91)	(21.60)	(21.33)	(15.28)
0.0244	(15.91)	(42.59)	-	(16.49)	(34.57)	(29.01)	(23.55)	(22.51)	(16.28)
0.0293	(18.40)	(44.68)	-	(17.62)	(39.18)	(30.66)	(25.10)	(23.53)	(17.17)
0.0341	(20.67)	(46.31)	-	(18.71)	(43.64)	(31.96)	(26.32)	(24.39)	(17.96)
0.0390	(22.74)	(47.55)	-	(19.75)	(47.93)	(32.97)	(27.28)	(25.10)	(18.62)
0.0439	(24.59)	(48.47)	-	(20.74)	(52.06)	(33.73)	(28.01)	(25.67)	(19.17)
0.0488	(26.25)	(49.12)	-	(21.68)	(56.00)	(34.28)	(28.55)	(26.10)	(19.60)
0.0536	(27.70)	(49.54)	-	(22.58)	(59.78)	(34.65)	(28.92)	(26.42)	(19.93)
0.0585	(28.97)	(49.76)	-	(23.44)	(63.38)	(34.87)	(29.16)	(26.63)	(20.15)
0.0634	(30.06)	(49.82)	-	(24.26)	(66.79)	(34.97)	(29.28)	(26.75)	(20.28)
0.0683	(30.99)	(49.74)	-	(25.04)	(70.02)	(34.95)	(29.30)	(26.79)	(20.33)
0.0731	(31.77)	(49.55)	-	(25.79)	(73.05)	(34.85)	(29.23)	(26.77)	(20.32)
0.0780	(32.42)	(49.26)	-	(26.50)	(75.86)	(34.67)	(29.11)	(26.70)	(20.24)
0.0829	(32.94)	(48.90)	-	(27.18)	(78.47)	(34.43)	(28.92)	(26.58)	(20.11)
0.0878	(33.36)	(48.47)	-	(27.81)	(80.86)	(34.15)	(28.70)	(26.43)	(19.94)
0.0926	(33.69)	(48.01)	-	(28.41)	(83.03)	(33.83)	(28.45)	(26.26)	(19.73)
0.0975	(33.94)	(47.50)	-	(28.96)	(85.01)	(33.49)	(28.18)	(26.07)	(19.50)
0.1024	(34.12)	(46.98)	-	(29.48)	(86.80)	(33.13)	(27.89)	(25.87)	(19.25)
0.1073	(34.25)	(46.43)	-	(29.96)	(88.42)	(32.76)	(27.60)	(25.66)	(18.99)
0.1121	(34.33)	(45.88)	-	(30.40)	(89.87)	(32.39)	(27.30)	(25.45)	(18.71)
0.1170	(34.37)	(45.33)	-	(30.81)	(91.18)	(32.02)	(27.01)	(25.24)	(18.44)

Appendix Table B17. Certainty Equivalents by Risk Attitude for Durum Fixed Price Contract with AOG by Level of Discount for AOG Provisions ($/a)

ARAC	HAD FP AOG Discount $0/bu	HAD FP AOG Discount $0.25/bu	HAD FP AOG Discount $0.50/bu	HAD FP AOG Discount $0.75/bu	HAD FP AOG Discount $1.00/bu
0	67.38	62.39	57.40	52.41	47.42
0.0049	62.90	57.92	52.93	47.94	42.95
0.0098	58.82	53.83	48.85	43.86	38.87
0.0146	55.06	50.08	45.10	40.11	35.13
0.0195	51.59	46.61	41.63	36.65	31.67
0.0244	48.38	43.40	38.42	33.44	28.46
0.0293	45.40	40.42	35.45	30.47	25.50
0.0341	42.64	37.67	32.69	27.72	22.74
0.0390	40.08	35.11	30.14	25.16	20.19
0.0439	37.69	32.73	27.76	22.79	17.82
0.0488	35.48	30.51	25.55	20.58	15.61
0.0536	33.41	28.45	23.48	18.52	13.55
0.0585	31.48	26.52	21.56	16.59	11.63
0.0634	29.67	24.71	19.75	14.79	9.82
0.0683	27.98	23.02	18.06	13.09	8.13
0.0731	26.38	21.42	16.46	11.50	6.54
0.0780	24.87	19.91	14.96	9.99	5.03
0.0829	23.44	18.49	13.53	8.57	3.61
0.0878	22.09	17.14	12.18	7.22	2.26
0.0926	20.81	15.85	10.90	5.94	0.97
0.0975	19.58	14.63	9.67	4.71	(0.25)
0.1024	18.41	13.46	8.51	3.55	(1.42)
0.1073	17.30	12.35	7.39	2.43	(2.53)
0.1121	16.23	11.28	6.32	1.36	(3.60)
0.1170	15.21	10.26	5.30	0.34	(4.62)

Appendix Table B18. Risk Premiums Relative to HRS Hedged by Risk Attitude for Durum Fixed Price Contract with AOG by Level of Discount for AOG Provisions ($/a)

ARAC	HAD FP AOG Discount $0/bu	HAD FP AOG Discount $0.25/bu	HAD FP AOG Discount $0.50/bu	HAD FP AOG Discount $0.75/bu	HAD FP AOG Discount $1.00/bu
0	(12.54)	(17.53)	(22.52)	(27.51)	(32.51)
0.0049	(14.29)	(19.28)	(24.27)	(29.26)	(34.25)
0.0098	(15.88)	(20.86)	(25.85)	(30.83)	(35.82)
0.0146	(17.32)	(22.30)	(27.28)	(32.27)	(37.25)
0.0195	(18.62)	(23.60)	(28.58)	(33.56)	(38.54)
0.0244	(19.79)	(24.77)	(29.75)	(34.73)	(39.71)
0.0293	(20.84)	(25.82)	(30.79)	(35.77)	(40.75)
0.0341	(21.77)	(26.75)	(31.72)	(36.69)	(41.67)
0.0390	(22.60)	(27.57)	(32.54)	(37.51)	(42.49)
0.0439	(23.33)	(28.29)	(33.26)	(38.23)	(43.20)
0.0488	(23.97)	(28.93)	(33.90)	(38.87)	(43.84)
0.0536	(24.53)	(29.49)	(34.46)	(39.42)	(44.39)
0.0585	(25.02)	(29.99)	(34.95)	(39.91)	(44.88)
0.0634	(25.46)	(30.42)	(35.38)	(40.35)	(45.31)
0.0683	(25.85)	(30.81)	(35.77)	(40.73)	(45.70)
0.0731	(26.20)	(31.16)	(36.12)	(41.08)	(46.04)
0.0780	(26.52)	(31.47)	(36.43)	(41.39)	(46.36)
0.0829	(26.80)	(31.76)	(36.72)	(41.68)	(46.64)
0.0878	(27.07)	(32.02)	(36.98)	(41.94)	(46.90)
0.0926	(27.31)	(32.26)	(37.22)	(42.18)	(47.14)
0.0975	(27.53)	(32.49)	(37.44)	(42.40)	(47.37)
0.1024	(27.75)	(32.70)	(37.65)	(42.61)	(47.58)
0.1073	(27.95)	(32.90)	(37.86)	(42.81)	(47.78)
0.1121	(28.14)	(33.09)	(38.05)	(43.01)	(47.97)
0.1170	(28.32)	(33.27)	(38.23)	(43.19)	(48.15)

Appendix Table B19. Certainty Equivalents by Risk Attitude for Contract Alternatives with AOG Clauses

ARAC	HRS Unpriced	HAD Unpriced	HRS Hedged	HAD Fix Price	HAD Fix Spread	HAD Min 8.0	HAD Min 8.50	HAD Min/Max	HAD FP AOG
0	79.92	62.69	79.92	67.38	67.38	68.75	71.55	64.11	67.38
0.0049	73.83	51.53	77.19	62.90	61.12	58.72	61.91	58.78	62.90
0.0098	68.16	43.23	74.70	58.82	55.27	51.31	54.77	54.03	58.82
0.0146	62.85	36.61	72.38	55.06	49.75	45.40	49.07	49.74	55.06
0.0195	57.83	31.11	70.21	51.59	44.52	40.47	44.30	45.85	51.59
0.0244	53.09	26.40	68.17	48.38	39.57	36.22	40.17	42.31	48.38
0.0293	48.59	22.31	66.24	45.40	34.87	32.48	36.53	39.07	45.40
0.0341	44.34	18.70	64.41	42.64	30.41	29.16	33.28	36.10	42.64
0.0390	40.31	15.50	62.68	40.08	26.19	26.18	30.35	33.38	40.08
0.0439	36.51	12.64	61.02	37.69	22.19	23.47	27.68	30.86	37.69
0.0488	32.93	10.06	59.44	35.48	18.41	21.02	25.25	28.54	35.48
0.0536	29.57	7.73	57.94	33.41	14.84	18.77	23.02	26.39	33.41
0.0585	26.40	5.61	56.51	31.48	11.47	16.70	20.96	24.39	31.48
0.0634	23.43	3.68	55.14	29.67	8.29	14.79	19.05	22.53	29.67
0.0683	20.65	1.90	53.83	27.98	5.30	13.02	17.27	20.79	27.98
0.0731	18.04	0.27	52.58	26.38	2.47	11.37	15.61	19.15	26.38
0.0780	15.60	(1.24)	51.39	24.87	(0.20)	9.83	14.06	17.62	24.87
0.0829	13.31	(2.64)	50.25	23.44	(2.72)	8.39	12.60	16.16	23.44
0.0878	11.17	(3.94)	49.16	22.09	(5.10)	7.03	11.22	14.79	22.09
0.0926	9.16	(5.16)	48.11	20.81	(7.35)	5.76	9.92	13.49	20.81
0.0975	7.27	(6.30)	47.12	19.58	(9.49)	4.55	8.69	12.25	19.58
0.1024	5.49	(7.36)	46.16	18.41	(11.51)	3.41	7.52	11.07	18.41
0.1073	3.81	(8.37)	45.25	17.30	(13.43)	2.32	6.40	9.94	17.30
0.1121	2.23	(9.32)	44.37	16.23	(15.25)	1.29	5.34	8.86	16.23
0.1170	0.74	(10.21)	43.53	15.21	(16.98)	0.30	4.32	7.82	15.21

Appendix Table B20. Risk Premiums Relative to HRS Hedged by Risk Attitude for Contract Alternatives with AOG Clauses

ARAC	HRS Unpriced	HAD Unpriced	HRS Hedged	HAD Fix Price	HAD Fix Spread	HAD Min 8.0	HAD Min 8.50	HAD Min/Max	HAD FP AOG
0	0.00	(17.24)	-	(12.54)	(12.54)	(11.17)	(8.37)	(15.81)	(12.54)
0.0049	(3.36)	(25.66)	-	(14.29)	(16.07)	(18.47)	(15.29)	(18.41)	(14.29)
0.0098	(6.53)	(31.47)	-	(15.88)	(19.43)	(23.39)	(19.92)	(20.67)	(15.88)
0.0146	(9.53)	(35.77)	-	(17.32)	(22.63)	(26.98)	(23.30)	(22.64)	(17.32)
0.0195	(12.38)	(39.11)	-	(18.62)	(25.69)	(29.74)	(25.91)	(24.36)	(18.62)
0.0244	(15.08)	(41.77)	-	(19.79)	(28.60)	(31.95)	(28.00)	(25.86)	(19.79)
0.0293	(17.65)	(43.94)	-	(20.84)	(31.37)	(33.76)	(29.71)	(27.17)	(20.84)
0.0341	(20.08)	(45.71)	-	(21.77)	(34.00)	(35.25)	(31.14)	(28.31)	(21.77)
0.0390	(22.36)	(47.17)	-	(22.60)	(36.49)	(36.50)	(32.33)	(29.30)	(22.60)
0.0439	(24.51)	(48.38)	-	(23.33)	(38.83)	(37.55)	(33.34)	(30.16)	(23.33)
0.0488	(26.51)	(49.38)	-	(23.97)	(41.03)	(38.43)	(34.19)	(30.90)	(23.97)
0.0536	(28.38)	(50.21)	-	(24.53)	(43.10)	(39.17)	(34.92)	(31.55)	(24.53)
0.0585	(30.11)	(50.89)	-	(25.02)	(45.03)	(39.81)	(35.55)	(32.11)	(25.02)
0.0634	(31.70)	(51.46)	-	(25.46)	(46.84)	(40.35)	(36.09)	(32.61)	(25.46)
0.0683	(33.18)	(51.92)	-	(25.85)	(48.53)	(40.81)	(36.56)	(33.04)	(25.85)
0.0731	(34.54)	(52.31)	-	(26.20)	(50.11)	(41.21)	(36.97)	(33.43)	(26.20)
0.0780	(35.78)	(52.63)	-	(26.52)	(51.59)	(41.56)	(37.33)	(33.77)	(26.52)
0.0829	(36.93)	(52.89)	-	(26.80)	(52.97)	(41.86)	(37.65)	(34.08)	(26.80)
0.0878	(37.99)	(53.10)	-	(27.07)	(54.26)	(42.12)	(37.93)	(34.37)	(27.07)
0.0926	(38.96)	(53.27)	-	(27.31)	(55.47)	(42.36)	(38.19)	(34.63)	(27.31)
0.0975	(39.85)	(53.41)	-	(27.53)	(56.60)	(42.56)	(38.43)	(34.87)	(27.53)
0.1024	(40.67)	(53.52)	-	(27.75)	(57.67)	(42.75)	(38.64)	(35.09)	(27.75)
0.1073	(41.43)	(53.61)	-	(27.95)	(58.67)	(42.92)	(38.84)	(35.31)	(27.95)
0.1121	(42.13)	(53.68)	-	(28.14)	(59.61)	(43.08)	(39.03)	(35.51)	(28.14)
0.1170	(42.78)	(53.74)	-	(28.32)	(60.50)	(43.22)	(39.21)	(35.70)	(28.32)