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Procurement Risks and Strategies to Improve Quality Consistency in Wheat Shipments

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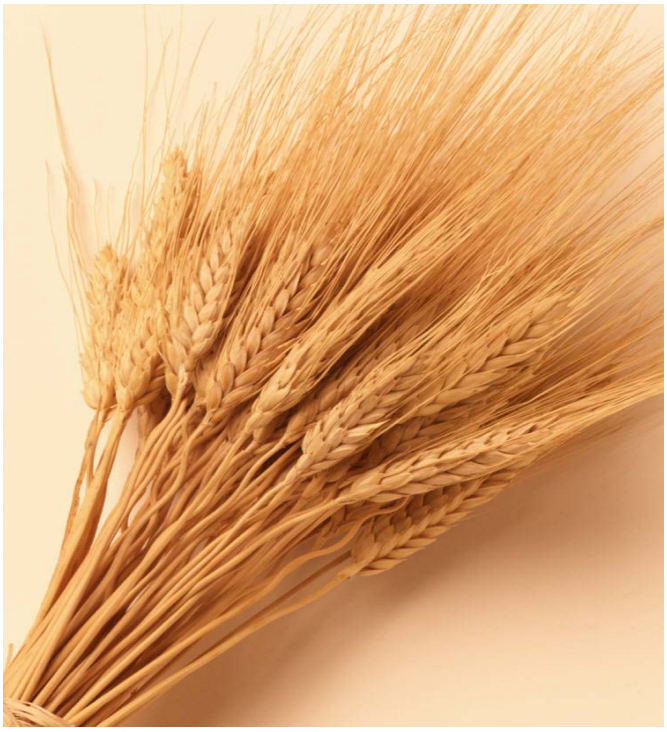

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Abstract

Consistency of functional characteristics in wheat is a concern confronting buyers and sellers. This research analyzes the cost and risk of different procurement strategies for importers. A stochastic simulation model is used to determine the probability of a functional characteristic being satisfied subject to quality targets and costs for alternative purchase strategies (purchase by protein only, variety, location, variety by location, or functional tests). Joint probabilities of meeting specifications and costs were determined for the alternative purchase strategies. Stochastic dominance was used to determine which purchase strategies dominate others, and stochastic efficiency was utilized to determine the degree of preference. Results indicate that, as more specific characteristics are incorporated into a contract, the probabilities of meeting end-use requirements increase. Requirements of specific characteristics come with a higher cost, due to increased testing costs related to identity preservation. Risk premiums for alternative strategies were derived.

Key Words: Buying Strategies, Location, Variety, Functional Characteristic Tests, Costs, Risks, Simulation, Stochastic Dominance

Procurement Risks and Strategies to Improve Quality Consistency in Wheat Shipments

William W. Wilson and Bruce L. Dahl[*]

Introduction

The changing competition among wheat buyers, largely due to the increased privatization of wheat importing functions, has led to increased demand for high quality wheat. Wheat suppliers, on the other hand, are subject to a more diverse supply of wheat varieties and production processes. Taken together, consistency of functional characteristics (absorption, peak time, loaf volume, and stability) in wheat has emerged as a problem of quality uncertainty confronting buyers and sellers. Quality uncertainty usually refers to variability in functional performance and arises from a combination of varietal differences, agronomic practices, environmental conditions, and handling and marketing practices. Assuring quality for functional characteristics is problematic because these are not easily measurable, require laboratory testing, and, therefore, are not commonly used in procurement contracts.

Given the inherent risk in wheat purchases, alternative purchase strategies have emerged to mitigate risks of quality inconsistency. Examples include varying forms of specifying higher levels of grain characteristics, varying forms of identity preservation (IP), specifying varieties, targeting locations, or specifying limits on functional characteristics. Each of these have differing impacts on costs and risks of meeting expected requirements.

The purpose of this study is to analyze the costs and risks of alternative procurement strategies that can be used by international wheat end-users to mitigate quality inconsistency. We used stochastic dominance to evaluate risk-efficient buyer preferences for different purchase strategies and stochastic efficiency to determine the degree of preferences. The model quantifies costs and risks for different procurement strategies and is applied to the case of hard red spring (HRS) wheat. The model poses procurement strategies inclusive of grade and protein, targeted varieties and locations, and several functional trait tests. Then, stochastic dominance was applied to determine which purchase strategies dominate others, and stochastic efficiency was applied to estimate where preferences change and the degree of preference. The first section below provides a background discussion. The following sections describe the quality, price, and cost statistics used in the analysis, how the empirical model was specified, and the results. The final section draws some implications for buyers and sellers. This study contributes to the literature on risk and grain quality as it furthers the definition of quality consistency and provides a framework to evaluate strategies to mitigate risk.

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Background and Previous Studies

Dahl and Wilson (1998) defined three elements of quality consistency. One is quality variability due to sampling and grading errors. Second is the variability of grain characteristics in shipments taken from different regions and climatic areas. Among these characteristics are those that are easily measurable (e.g., protein and damage) and other characteristics with greater measurement error. For characteristics that are susceptible to greater measurement error, there are greater risks. The third element relates to functional performance (i.e., mixing and baking characteristics). End-users see this inconsistency as a major hurdle which is reflected in the relationship between functional performance and measurable characteristics. Buyers normally specify easily measurable characteristics which are correlated with desirable functional characteristics. Poor correlations result in greater uncertainty in functional performance or greater inconsistency.

Dahl and Wilson (1998) documented the variability of quality for HRS wheat at different points throughout the production and marketing system and found that quality variability decreased as it moved from farm-level production to export locations. The variability of wheat and functional characteristics was examined to determine the contribution of variety, location, and environment to the variation in individual quality characteristics. Variability was impacted most by year-to-year effects (i.e., environment), followed by location and variety effects. Variability in quality measured as mix tolerance index (MTI) and wet gluten were affected most by location and variety, whereas, mix time was affected most by environment and variety. Therefore, buyers may increase consistency of purchases by focusing on location and/or varieties.

The shift toward privatization of wheat imports is another factor affecting changes in quality purchased (Wilson 1996a, b). Privatization results in a tendency for more specificity in purchase contracts. Generally, private buyers have a greater incentive to evaluate the value of higher quality and are more willing to pay premiums (and discounts) if that greater (lower) quality enhances (reduces) their profits. Procurement strategies, i.e., the combination of price and quality specifications, are critical factors in the HRS wheat market with some importers using more stringent contract specifications than U.S. domestic millers. Contract specifications have considerable strategic importance, particularly in view of competition among buyers (Johnson, Wilson, and Diersen 2001). In addition to wheat protein, some countries have been working to purchase IP shipments and/or varieties including Wharburtons from the Canadian Wheat Board (Kennett et al. 1998) and General Mills in the United States (Taylor, Brester, and Boland 2005).

International competition in wheat is quickly having to focus on consistency. The market is more sophisticated in segregating for quality and more demanding buyers generally have the impact of increasing specificity of contracts (Oades 2001a). Procurement strategies utilized by wheat end-users range from simple spot market transactions to elaborate vertical integration techniques (Figure 1). Strategies that fall in between these extremes are numerous and often considered the norm. Examples of these strategies include contracting, testing and segregation

practices, targeting of origins and varieties, contracting production practices and identifying preservation (Figure 1) (Wilson and Preszler 1992; Wilson, Dahl, and Johnson 2000; Wilson and Dahl 2006; Wilson, Nganje, and Wagner 2006; Wilson, Dahl, and Jabs 2007). Though contracting is currently less common in the wheat sector (McDonald et al. 2004), the results here suggest the importance of contracting to assure improved consistency.

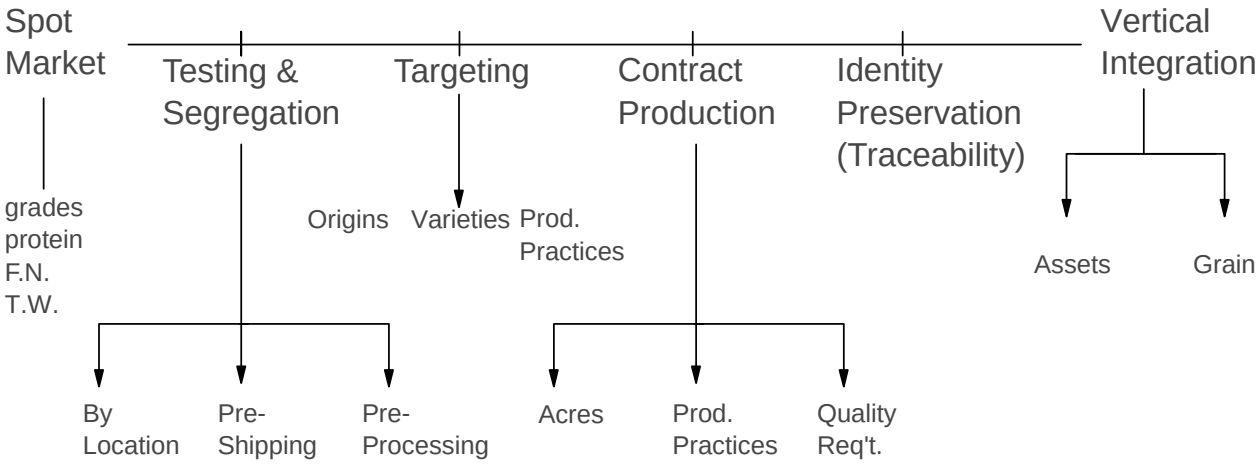

Figure 1. Spectrum of Procurement Strategies

Testing and segregation practices by end-users often entail targeting locations accompanied by either pre-shipment or pre-processing testing. Targeting origins and varieties consists of purchasing wheat from a given county or region and purchasing a particular variety. Specific production practices involve contracting a desirable acreage to be produced, overseeing the production practices, and requiring the final product to meet desirable quality requirements. IP requirements include preserving wheat characteristics throughout the entire production and transportation process (Smyth and Phillips 2000; Hobbs 2004, Kennet et al. 1998).

Hard wheat is usually marketed on a grade and protein basis which is based on grain factors due to convenience of grade standards. Specifications are a part of the purchase contract and affect price. Grain factors normally certified on export cargoes are numerical grade, class, moisture content, protein content, and dockage content. Contract terms define minimum acceptable levels. There is a direct relationship between price and risk in international wheat contracting. Other specifications can be included, but in the United States would not normally be assured as part of the official inspection system. These include specifying varieties, targeted locations, or functional characteristics. Each of these would involve more elaborate contractual specifications and non-official evaluation. Certification of additional quality factors can also be specified in the contract and be performed and certified by the USDA's Federal Grain Inspection Service or a private company (U.S. Wheat Associates 2001).

Use of non-conventional specifications or requirements creates uncertainty and risk throughout the system which are absorbed by sellers. Some U.S. end-users have begun the process of contracting the production of selected wheat varieties (Willis 2001). Variety-specific procurement strategies help end-users meet both economic and functional quality requirements which they are unable to achieve through normal commodity market channels.

Most major wheat exporting countries have been analyzing institutions impacting exports and quality.[1] The European Union (EU) changed their intervention policy to encourage adoption of varieties with higher end-use characteristics. In Canada, much of the debate has been on topics related to kernel visual distinguishability (KVD). Varieties are classed using visual techniques, and this system has been challenged due to its high cost and because it inhibits advances in productivity. Results of recent studies have analyzed the costs (Furtan, Burden, and Scott 2003) and benefits (Oleson 2003) of alternatives.

The Grains Council of Australia (1995) concluded that a large portion of the variability in prices received by the Australian Wheat Board was due to variability in quality characteristics. More recently, Australia is evolving toward increased emphasis on niche marketing whereby varieties and production regions are being matched to customer needs. Specifically, the new AWB *Golden Rewards Varietal Systems* (ProFarmer Australia 2004) provides a clear indication of their escalation in varietal marketing with an emphasis on protein. Argentina has studied its system with respect to differences among varieties and the inability to classify them according to functional differences (Cuniberti and Otamendi 2004) and changes have been implemented to class varieties by functional traits.

Not conforming to end-use requirements has important implications for buyers. These include the risk of not conforming to contract specifications, greater costs associated with higher quality purchases, and/or the effects of increased operating costs associated with likely stock-out costs due to non-conformance). Wheat quality characteristics (e.g., protein and test weight) that are easily measurable in a timely manner are typically used for contracting. Functional characteristics (e.g., stability and peaktime) are not easily measurable, but statistical relationships exist between wheat quality and functional characteristics. Though it has not been conventional to use functional characteristics in contracting for wheat procurement, buyers and end-users are ultimately concerned with these characteristics.

Empirical Model

Stochastic simulation was used to simulate costs and risks of alternative procurement strategies including: purchases based on wheat protein levels, varieties, locations, and functional characteristics. The models estimate procurement costs and risks and are used to determine the probability that shipments would meet end-user requirements for alternative strategies. Statistical relationships between wheat and functional characteristics were estimated and utilized

[1] See Canada Grains Council (2005) for a set of presentations on this subject.

to derive probability distributions for meeting functional conformance for each of the alternative purchase strategies. Stochastic variables include basis values, premiums and functional characteristics. Costs for procuring wheat are estimated inclusive of purchase costs, shipping, and tests required for each of the strategies. Then, simulated distributions of costs and risks for alternative procurement strategies were compared using Stochastic Dominance with Respect to a Function (SDRF) to determine risk efficient purchase strategies and Stochastic Efficiency with Respect to a Function (SERF) to examine effects of the level of risk aversion on preferences and to estimate the degree of preference.

There are three steps in our analytical methodology. First, we estimate functional relationships for each purchase strategy for functional characteristics for each alternative purchase strategy. Second, we use stochastic simulation to iterate 1,000 outcomes of costs/risks for each alternative. Results from these are collected and used to define distributions for each choice. Third, we use both stochastic dominance and stochastic efficiency techniques (described below) to create rankings amongst the choices at the extremes of a range of Arrow-Pratt absolute risk aversion coefficients and to estimate certainty equivalents/risk premiums. The order and size of certainty equivalents/risk premiums yields information on decision maker preferences and the degree of preference across risk attitudes. The data and distributions are described first,and then we explain the stochastic methodology.

Data Sources and Distributions

In order for buyers to purchase grain from specific origins, they must effectively bid grain away from competitors, and local origin prices would reflect the best bid available from all markets. Two prices were defined given intermarket competition. Specifically, the costs of delivering HRS to each market i from each location j were defined as:

$$(1) \qquad P_{ij} = F + Max(B_{1j}-T_{1j},B_{2j}-T_{2j},B_{3j}-T_{3j}) + T_{ij} + X_I + RC*(1- \prod Y_k)$$

where P_{ij} is the price of HRS at market i (1=PNW, 2=Gulf, and 3=Minneapolis) from location j (j=1-20, representing 20 crop reporting districts within the HRS production area); F is the futures price; B_{ij} is the basis value for market i from origin j; T_{ij} is the shipping cost to market i from location j; X_i is the testing/verification cost for market i, RC is the rejection cost when lots do not meet joint specifications for the vector **k** of functional characteristics, and $\prod Y_k$ is the joint probability of meeting specifications for the vector **k** of functional characteristics.

Twenty locations defined as crop reporting districts (CRDs) throughout the HRS wheat-producing region were used. Prices at each location (CRD) are determined through inter-market competition between three markets: Minneapolis, the Pacific Northwest (PNW), and ports on the U.S. Gulf. Basis differentials and freight rate relationships cause the purchasing costs to vary geographically. Average costs and probabilities of conforming to requirements were determined for supplying the PNW market from each CRD.

Since the futures value would affect all strategies similarly, a fixed value was assumed. Distributions for the basis were normal with means and standard deviations in parentheses of 35 c/bu (34 c/bu) for Minneapolis and 78 c/bu (38 c/bu) for the export ports, which are representative of monthly observations for Minneapolis and export basis from August 1991 to July 2002. The correlation of basis values for the period 1991 to 2002 was .92 between Minneapolis and export basis values and incorporated in the simulation model. Shipping costs were for 52 car rates taken from the Burlington Northern Sante Fe Railroad for each CRD.

Testing costs for location and variety were obtained from CII Laboratories (2002) and functional characteristic testing costs from the Canadian Grain Commission (2002) were used. Costs were $100/sample for a location monitoring test (e.g., auditing), $300/sample for an electrophoresis variety test, $40/sample for a farinograph test, $30/sample for a loaf volume test, and $17/sample for a flour protein test. Each sample was assumed representative of every two grain cars (i.e., every 6,600 bushels). Some testing costs were elusive, as they are not yet extensively used. Therefore, approximate costs were used in simulation to measure probabilities.
If lots did not meet specifications, wheat was considered to be diverted to other customers where it would compete with HRW quality wheats. In those cases, a rejection cost (RC) equivalent to the average spread between HRS 14% at Minneapolis and Kansas City Ordinary Protein HRW wheat for 1999-2000 (53.46 c/bu) was added to the procurement cost.

Wheat Quality Characteristics

Functional characteristic requirements are shown in Table 1 and were obtained from industry representatives. Ultimately these are the requirements in the model and would vary across end uses, countries, and processing technologies. Those in Table 1 are fairly typical of products (e.g., frozen dough, blends, variety breads) produced from HRS.

All wheat and functional characteristic data were obtained from a Spring Wheat Baker's (SWB) data set for the 1999 and 2000 harvest years.[2] It includes functional and wheat characteristics representative of the entire HRS producing region. The data set is comprised of 316 samples. Simple statistics and correlations for each variable, including wheat protein, moisture level, falling number, test weight, thousand kernel weight, stability, peaktime, ash content, loaf volume, absorption, extraction, and flour protein, are shown in Tables 2 and 3. Data were fit to distributions for each using fitting capabilities within *@Risk* (Palisade, 1997). Fitted distributions and shape parameters are shown in Table 2.

[2] Other sources of publically accessible data on wheat quality exist, but generally these are evaluated on a composite sample basis or limited in number of observations available making them less desirable for the stochastic analysis used in this study.

Table 1. Wheat and Functional Characteristic Requirements

Wheat and Functional Characteristics	Target Value
Wheat Characteristics	
Wheat Protein (%)	14.2
Test Weight (lbs./bushel)	60
Moisture (%)	12.5
Falling Number (sec.)	400
1,000 Kernel Weight (g.)	30
Functional Characteristics	
Absorption (%)	62
Peak time (min.)	7
Stability (min.)	14
Loaf Vol. (cc./100g. Loaf)	1000
Flour Characteristics	
Flour protein (%)	12
Extraction (%)	68
Ash (% dry basis)	0.47

Table 2. Data Statistics and Estimated Distribution Parameters for Wheat and End-Use Characteristics

	Data Statistics			Fitted Distribution and Parameters		
Variable	N	Mean	Std Dev	Distribution	Param. 1	Param. 2
Wheat Protein	306	14.42	0.83	Normal	14.42	0.87
Test Weight	316	60.25	1.43	Normal	60.21	1.49
Moisture level	316	12.32	0.93	Normal	12.35	0.96
Falling Number	308	437.51	54.73	Normal	437.52	54.72
1,000 KW	313	30.74	2.55	Logistic	30.65	1.36
Absorption	243	62.89	1.98	Normal	62.83	1.93
Peaktime	242	8.91	2.11	Ext. Value	8.01	1.62
Stability	242	17.66	6.21	Normal	17.61	6.29
Extraction	312	69.39	4.44	Logistic	69.65	1.46
Loaf Volume	314	11.96	2.88	Logistic	11.71	1.62
Ash	145	0.51	0.04	Normal	12.71	0.39
Flour Protein	145	12.71	0.76	Logistic	0.46	0.04

Table 3. Correlations Between Wheat and Functional Characteristics

	Moist	Falling No.	Test Wt.	1,000 Kernel Wt.	Absorption	Peaktime	Stability	Loaf Volume
Moisture	1.00	-0.16	-0.24	0.15	-0.33	-0.13		-0.17
Falling No.	-0.16	1.00	-0.18		0.13		0.26	0.17
Test Wt.	-0.24	-0.18	1.00		0.26		-0.34	
1,000 Kernel Wt	0.15			1.00		-0.21	-0.14	-0.23
Absorption	-0.33	0.13	0.26		1.00	0.26		1.00
Peaktime	-0.13	0.00		-0.21	0.26	1.00	-0.21	-0.16
Stability		0.26	-0.34	-0.14		-0.21	1.00	-0.24
Loaf Volume	-0.17	0.17		-0.23	1.00	-0.16	-0.24	1.00

* Missing values indicate correlations were not statistically significant at p=.05.

Separate regression models were estimated for each functional characteristic and interaction terms for location and variety were included to reflect differences associated with these parameters. All regressions included functional characteristics (e.g., peaktime) as dependent variables while independent variables (e.g., wheat characteristics, location dummy variables, and variety dummy variables) were altered to allow different effects imposed on the functional characteristics. The base model was specified as:

$$Y_k = f_1(X_t) + \varepsilon , \quad (2)$$

where Y_k is a vector of functional characteristics (i.e., absorption, stability, peaktime, loaf volume), X_t is a vector of wheat characteristics [i.e., wheat protein (%), test weight (lbs./bu), falling number (seconds), 1,000 kernel weight (g), and moisture level (%)], and ε is the error term. Specifications representing other strategies included:

$$Y_{k=} f_2(X_t, V_{m,n}) + \varepsilon , \quad (3)$$

where $V_{m,n}$ is variety m in sample n, and

$$Y_k = f_3(X_t, L_{ij}) + \varepsilon , \quad (4)$$

where L_{ij} is location j delivered to market i.

Significant t-statistics at a 5% level were considered in choosing which characteristics were significant. Insignificant variables were excluded. Results are shown in Appendix Tables 1-5.

The probability of characteristic k conforming to a requirement was defined as:

$$\text{Prob}\ (Y_k = 1) \quad (5)$$

and the joint probability for the wheat lot as:

(6) $$\text{Prob}\left(\prod Y_k = 1\right)$$

where $Y_k = 1$ if the quality target for the functional characteristic k is satisfied, $\prod Y_k = 1$ is the joint probability of quality specifications for all functional characteristics is satisfied, and k= 1…….n, representing absorption, peak time, stability, and loaf volume.

Stochastic Simulation and Dominance

Stochastic simulation was used to determine procurement costs and risks of alternative strategies to the PNW. The simulation determined the procurement costs from each individual CRD and the probability of meeting individual and joint end-user requirements. The model is simulated using @Risk (Palisade, 1997). One thousand iterations of each model were run, at which time acceptable stopping criteria were reached. The simulation incorporated correlations between functional characteristics within the model. The RMSE of the estimated equations was the measure of uncertainty for each functional characteristic constructing the right hand side variables. Risk is incorporated by inclusion of rejection costs (RC) for lots not meeting joint specifications for the desired end-use requirements (i.e., assumes HRS lots not meeting specifications would be resold to alternative HRW market at a discount, described above). Sensitivities for delivery to alternative markets were examined.

Four separate procurement strategies were simulated. Base case strategies included wheat characteristics (e.g., protein and test weight). Other strategies added specifications for varieties, location [represented by CRD (e.g., L-1 to L-20)], and functional characteristic requirements. These converged to contract strategies using protein specification only and specifications including variety, location, and functional specifications. Four alternative functional characteristic tests were evaluated, including absorption (%), loaf volume (cc per 100 gram loaf), stability (minutes), and that representative of a farinograph test (which assumed jointly meeting specifications for absorption, peaktime, and stability).

Distributions of procurement costs and probability of meeting specifications for individual purchase strategies were derived from the stochastic simulation results. The distributions for costs were inverted by subtracting all procurement costs from 1,000. (This effectively inverts rankings of strategies so that highest costs will be least preferred and is equivalent to adding a fixed value to negative cost values to obtain positive values). These inverted cost distributions were compared using SDRF and SERF.

Stochastic dominance was used to determine risk efficient decisions among purchase strategies. It allows behavioral assumptions by decision makers to be explicitly accounted for and provides a theoretically sound comparison of the risky alternatives. Generalized SDRF was used here because it allows behavioral assumptions by decision makers to be explicitly accounted for and provides a theoretically sound comparison of the purchase strategies. Outcomes for this model are based on expected utility from a distribution set.

SDRF encompasses first, second, and higher order stochastic dominance. SDRF allows the distribution of outcomes for the four choices to be compared to determine the best outcome, while accounting for grower risk aversion. *Simetar* was used in this analysis which determines first, second, and SDRF rankings of scenarios and allows sets of distributions to be compared, accounting for the risk in each distribution (Richardson, Schumann and Feldman 2005). The program ranks the distributions according to their risk efficiency and profit for a range of absolute risk aversion coefficients (ARAC). If different rankings are indicated for endpoints of the range of ARAC, then a subsequent analysis (SERF) is indicated to determine the ARAC where rankings change.

Finally, we conducted a SERF analysis to estimate certainty equivalents and risk premiums by ARAC to determine the risk attitude where preferences change and to estimate the degree of preferences for each of the purchase strategies. Certainty equivalents were computed assuming a negative exponential utility function which assumes constant absolute risk aversion (CARA) following Ribera, Hons, and Richardson (2004); Sangtaek, Mitchell and Leatham (2005); Babcock and Hennessy (1996); Kaylen, Loehman and Preckel (1989); and Lambert and McCarl (1985). The range of ARAC utilized was from -0.1 to 0.108 where the upper bound was estimated using the methods developed by McCarl and Bessler (1989). The estimated certainty equivalents indicate where the order of risk preferences change. The advantage of SERF analysis is that risk premiums are simply the difference between certainty equivalents of the alternatives. Risk premiums provide perspective on the degree of preference of decision makers for each of the alternative procurement specifications relative to the base distribution (here protein only) as risk attitudes change. The risk premiums are the amounts required for the decision maker to be indifferent between the choice and purchase by protein only and provide perspective on the magnitude of differences in relative preferences among choices. The premium indicates the change that would have to occur in the certainty equivalent of net payoffs in order to induce a change in preferences. The sign of premiums indicates the preference relative to the protein only case. Positive premiums indicate the alternative is preferred to the protein only strategy, while negative premiums indicate the protein only strategy is preferred.

Results and Sensitivities

Effect of Protein Specifications

The base case assumes buyers specify a minimum protein of 14.2% and quality (both wheat characteristics and end-use characteristics) is representative of that produced in the HRS wheat growing region. This strategy utilizes functional relationships between protein and other wheat characteristics to estimate end-use characteristic values and procurement costs. The strategy was simulated to determine the probability that each functional requirement is met. Sensitivities were conducted which evaluated alternative minimum protein purchase strategies (Table 4).

Table 4. Probability of Meeting Requirements (Protein Specified Only)

Characteristic	Prob. of Meeting Requirements					
Functional Characteristics	Base Case			Protein		
Protein Level	14.2%	13.0%	13.5%	14.0%	14.5%	15.0%
Absorption	.64	.41	.50	.60	.69	.77
Peak time	.80	.80	.80	.80	.80	.80
Stability	.70	.70	.70	.70	.70	.70
Loaf Volume	.74	.65	.70	.73	.76	.79
Joint Probability	.28	.15	.21	.26	.31	.36
Effective Proc. Cost (c/bu)	500	500	499	498	501	505

For the base case (protein = 14.2%), the average procurement cost was 500 c/bu and the joint probability of meeting all specifications was only .28. Sensitivities on the level of protein specified were conducted with values ranging from 13% to 15% at 0.5% intervals (Table 4). As the level of protein specified increases, the likelihood of conforming to requirements increases, but the procurement costs first decrease and then increase. This occurs largely in response to the effects of protein premiums/discounts and rejection costs which reflect the probability of meeting all specifications. At low protein levels, the effect of higher effective procurement costs due to not meeting specifications exceeds those of protein premiums required for higher protein levels which have higher probabilities of meeting specifications, so an increase in protein level results in lower effective procurement costs. At higher protein levels, the effects of protein premiums are higher than the rejection costs and, as such, effective procurement costs increase as protein levels increase.

It is notable that the probability of meeting specifications for peak time and stability are unchanged by increases in protein levels. This is a direct impact of estimated statistical relationships between wheat characteristics and peak time and stability which did not infer a statistically significant relationship between protein levels and either peak time or stability. Further, the low probabilities of meeting specifications for absorption reflect the low levels of absorption that occurred over the period of the data. Probabilities for meeting specifications for absorption would likely be higher for data covering a longer time frame.

Stochastic dominance analysis of the procurement costs of the alternative protein specifications and the base case indicated that 15% protein was the most preferred set across ARACs; however, the order of preference for many of the other alternatives varied by ARAC. Stochastic efficiency analysis indicated the degree of the preference or risk premium of 15% protein over the base case (14.2%) varied from 9.1 c/bu for the most risk preferring buyers to 3.2 c/bu for moderate risk aversion (ARAC = 0.06), and increased again to 4.0 c/bu for highly risk averse buyers (ARAC=0.108) (Table 5 and Figure 2). Thus, risk neutral to slightly risk averse decision makers would prefer the higher protein level buying strategy over the base case by 3 to 6 c/bu. Switching of preferred sets occurred for the remaining protein choices with 14.5% ranked as the second preferred set for risk preferring to slightly risk averse, but ranked fifth for

highly risk averse decision makers. The base case (14.2%) was the third preferred set for risk preferring decision makers and the second preferred set for highly risk averse decision makers.

Varieties and Wheat Characteristics

The second strategy included a variety requirement. This was defined as specifying purchase for one of the more popular varieties in recent years along with a minimum protein level. The eight varieties analyzed included the more popular varieties in recent years. These models utilized estimated relationships between functional characteristics and binary variables for variety along with wheat characteristics to simulate functional characteristics and the probability of meeting requirements. A testing cost of $300/sample (assuming one sample for every two rail cars) for an electrophoresis test was added to the average procurement cost per bushel to allow for targeting varieties.

The variety V6 had the least cost delivered PNW ($4.88/bu) and the highest probability of meeting all functional requirements (.59) and is followed by V2 with a cost of ($4.99/bu) and probability of meeting specifications of .38 (Table 6). Varieties V4, V1, and V3 have the lowest probability of meeting all functional requirements (.14 to .18) and were the highest cost ($5.10 to $5.12/bu). Average costs for varieties delivered declined as the probability of meeting specifications increased.

Stochastic dominance analysis indicated that dominance of varieties varied by ARAC (Figure 3).[3] For moderately risk averse to the most risk preferring decision makers, V6 was preferred to the base case protein only strategy, while for the most risk averse decision makers, V2 was preferred to both V6 and the protein only strategy. The risk premium over the protein only strategy for V6 ranged from 13 c/bu for slightly risk preferring (ARAC=-.0133) to a low of -3.6 c/bu for highly risk averse decision makers and for variety V2 from -3.3 c/bu for highly risk preferring to 4 c/bu for highly risk averse decision makers. All other varieties were dominated by the protein only strategy across the range of risk attitudes with V1 and V4 being least preferred for risk averse decision makers (ARAC=0 to .108) and V3 and V4 being least preferred for risk preferring decision makers (ARAC=-.1 to 0). For risk neutral to slightly risk averse decision makers, risk premiums were positive for only variety V6 (8 to 12 c/bu).

[3] An illustration of distributions utilized for stochastic dominance and stochastic efficiency analyses are shown in Appendix Figure 1.

Table 5. Risk Premiums for Purchase by Protein Level, Variety, Functional Trait, and Location, by ARAC

ARAC	Base Case 14.2%	13%	13.5%	14%	14.5%	15%	V1	V2	V3	V4	V5	V6	V7	V8	Abs.	Stab.	Loaf Vol.	Farinograph
-0.1000	-	-6.25	0.76	-2.37	8.53	9.10	-5.62	-3.28	-13.40	-7.94	-9.21	10.69	-3.57	-1.68	7.98	3.05	3.71	8.93
-0.0913	-	-6.17	0.35	-2.35	8.01	8.94	-5.93	-3.03	-13.48	-8.40	-9.27	10.70	-3.60	-1.52	8.24	3.07	3.88	9.43
-0.0827	-	-6.06	-0.08	-2.32	7.40	8.74	-6.31	-2.74	-13.59	-8.94	-9.38	10.78	-3.66	-1.38	8.53	3.07	4.05	10.01
-0.0740	-	-5.90	-0.53	-2.28	6.71	8.50	-6.80	-2.40	-13.71	-9.55	-9.55	10.94	-3.79	-1.28	8.85	3.06	4.19	10.69
-0.0653	-	-5.67	-0.95	-2.21	5.95	8.21	-7.39	-2.01	-13.82	-10.25	-9.76	11.19	-3.97	-1.25	9.20	3.03	4.31	11.51
-0.0567	-	-5.36	-1.32	-2.12	5.13	7.88	-8.09	-1.57	-13.87	-11.01	-9.98	11.52	-4.23	-1.32	9.59	2.99	4.37	12.48
-0.0480	-	-4.94	-1.59	-2.01	4.31	7.53	-8.89	-1.10	-13.81	-11.78	-10.17	11.90	-4.54	-1.50	10.02	2.95	4.34	13.63
-0.0393	-	-4.42	-1.73	-1.87	3.53	7.16	-9.69	-0.65	-13.56	-12.48	-10.24	12.31	-4.85	-1.81	10.48	2.91	4.21	14.93
-0.0307	-	-3.77	-1.74	-1.71	2.85	6.82	-10.39	-0.26	-13.04	-12.97	-10.09	12.69	-5.07	-2.21	10.95	2.87	3.96	16.32
-0.0220	-	-3.00	-1.64	-1.55	2.28	6.49	-10.81	-0.01	-12.23	-13.13	-9.66	12.98	-5.12	-2.65	11.35	2.85	3.62	17.66
-0.0133	-	-2.11	-1.46	-1.40	1.84	6.19	-10.85	0.06	-11.20	-12.87	-8.99	13.08	-4.95	-3.03	11.60	2.84	3.20	18.72
-0.0047	-	-1.13	-1.25	-1.28	1.51	5.88	-10.51	-0.03	-10.07	-12.22	-8.19	12.88	-4.64	-3.31	11.63	2.83	2.74	19.33
0.0040	-	-0.10	-1.08	-1.18	1.22	5.52	-9.91	-0.18	-8.96	-11.33	-7.40	12.28	-4.27	-3.50	11.38	2.80	2.26	19.41
0.0127	-	0.88	-1.07	-1.12	0.89	5.08	-9.17	-0.31	-7.96	-10.33	-6.70	11.21	-3.95	-3.65	10.89	2.75	1.75	19.01
0.0213	-	1.67	-1.32	-1.08	0.48	4.57	-8.42	-0.34	-7.11	-9.34	-6.14	9.67	-3.74	-3.78	10.19	2.65	1.25	18.29
0.0300	-	2.14	-1.86	-1.05	-0.01	4.06	-7.71	-0.24	-6.41	-8.43	-5.69	7.73	-3.64	-3.91	9.36	2.47	0.78	17.41
0.0387	-	2.23	-2.61	-1.03	-0.51	3.63	-7.08	0.01	-5.85	-7.64	-5.34	5.60	-3.65	-4.04	8.43	2.21	0.38	16.48
0.0473	-	2.00	-3.44	-1.02	-0.93	3.34	-6.54	0.39	-5.43	-6.97	-5.08	3.49	-3.72	-4.15	7.47	1.86	0.07	15.57
0.0560	-	1.53	-4.23	-1.01	-1.24	3.20	-6.10	0.88	-5.13	-6.42	-4.89	1.60	-3.85	-4.25	6.51	1.46	-0.14	14.71
0.0647	-	0.92	-4.91	-1.01	-1.45	3.18	-5.73	1.44	-4.92	-5.98	-4.75	0.03	-3.98	-4.33	5.60	1.06	-0.28	13.94
0.0733	-	0.28	-5.48	-1.02	-1.57	3.26	-5.44	2.02	-4.78	-5.62	-4.66	-1.19	-4.11	-4.39	4.77	0.70	-0.36	13.25
0.0820	-	-0.36	-5.95	-1.04	-1.64	3.40	-5.22	2.59	-4.69	-5.35	-4.61	-2.12	-4.23	-4.44	4.04	0.39	-0.41	12.65
0.0907	-	-0.97	-6.33	-1.06	-1.67	3.58	-5.04	3.12	-4.64	-5.14	-4.58	-2.79	-4.32	-4.47	3.41	0.14	-0.43	12.14
0.0993	-	-1.51	-6.65	-1.09	-1.68	3.78	-4.91	3.57	-4.60	-4.98	-4.56	-3.28	-4.38	-4.49	2.88	-0.05	-0.44	11.70
0.1080	-	-2.01	-6.91	-1.12	-1.69	3.99	-4.81	3.96	-4.58	-4.86	-4.55	-3.63	-4.43	-4.51	2.44	-0.19	-0.45	11.32

	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18	L19	L20
-0.1000	-45.77	-53.58	1.00	4.90	-0.64	-1.26	-1.26	-1.28	-8.39	-15.76	-44.97	-13.83	-49.48	-49.87	-14.87	-30.28	-48.60	-27.90	-47.96	-42.81
-0.0913	-45.35	-53.18	1.21	5.23	-0.48	-1.22	-1.22	-1.24	-8.36	-16.00	-44.61	-13.83	-49.33	-49.39	-14.40	-29.70	-48.20	-27.22	-47.56	-42.22
-0.0827	-44.88	-52.71	1.42	5.58	-0.29	-1.17	-1.17	-1.20	-8.32	-16.20	-44.20	-13.80	-49.13	-48.86	-13.91	-29.09	-47.74	-26.47	-47.12	-41.58
-0.0740	-44.33	-52.17	1.62	5.94	-0.09	-1.13	-1.13	-1.17	-8.30	-16.37	-43.75	-13.73	-48.87	-48.27	-13.40	-28.44	-47.21	-25.66	-46.64	-40.89
-0.0653	-43.72	-51.56	1.80	6.31	0.14	-1.09	-1.10	-1.16	-8.28	-16.46	-43.25	-13.63	-48.51	-47.62	-12.87	-27.74	-46.60	-24.78	-46.11	-40.13
-0.0567	-43.03	-50.86	1.94	6.66	0.38	-1.07	-1.08	-1.16	-8.29	-16.47	-42.70	-13.50	-48.00	-46.91	-12.33	-27.02	-45.92	-23.83	-45.50	-39.33
-0.0480	-42.26	-50.09	2.03	6.99	0.62	-1.09	-1.10	-1.20	-8.34	-16.36	-42.09	-13.33	-47.27	-46.14	-11.79	-26.26	-45.15	-22.83	-44.79	-38.47
-0.0393	-41.42	-49.24	2.03	7.26	0.82	-1.15	-1.16	-1.29	-8.43	-16.11	-41.41	-13.12	-46.22	-45.32	-11.25	-25.49	-44.31	-21.80	-43.91	-37.56
-0.0307	-40.51	-48.31	1.95	7.46	0.96	-1.27	-1.28	-1.42	-8.56	-15.71	-40.62	-12.86	-44.78	-44.45	-10.73	-24.69	-43.40	-20.78	-42.78	-36.62
-0.0220	-39.54	-47.32	1.78	7.55	1.01	-1.42	-1.43	-1.58	-8.71	-15.17	-39.68	-12.56	-42.90	-43.52	-10.20	-23.88	-42.42	-19.82	-41.36	-35.64
-0.0133	-38.52	-46.28	1.55	7.52	0.97	-1.58	-1.59	-1.72	-8.85	-14.55	-38.56	-12.22	-40.66	-42.51	-9.66	-23.05	-41.39	-18.96	-39.63	-34.62
-0.0047	-37.44	-45.19	1.27	7.35	0.88	-1.70	-1.70	-1.81	-8.92	-13.93	-37.27	-11.86	-38.20	-41.42	-9.08	-22.19	-40.31	-18.24	-37.66	-33.59
0.0040	-36.33	-44.06	0.95	7.02	0.79	-1.74	-1.75	-1.83	-8.92	-13.39	-35.84	-11.54	-35.68	-40.23	-8.47	-21.31	-39.19	-17.64	-35.57	-32.53
0.0127	-35.17	-42.87	0.60	6.50	0.78	-1.73	-1.73	-1.79	-8.86	-12.98	-34.33	-11.28	-33.23	-38.94	-7.85	-20.42	-38.02	-17.13	-33.46	-31.45
0.0213	-33.95	-41.60	0.23	5.79	0.89	-1.68	-1.68	-1.72	-8.77	-12.69	-32.76	-11.13	-30.91	-37.55	-7.23	-19.52	-36.79	-16.68	-31.41	-30.33
0.0300	-32.67	-40.26	-0.15	4.90	1.15	-1.62	-1.62	-1.65	-8.68	-12.54	-31.16	-11.10	-28.74	-36.08	-6.64	-18.63	-35.48	-16.25	-29.47	-29.19
0.0387	-31.32	-38.83	-0.51	3.91	1.58	-1.57	-1.57	-1.59	-8.61	-12.49	-29.55	-11.19	-26.72	-34.55	-6.13	-17.78	-34.10	-15.84	-27.66	-28.04
0.0473	-29.95	-37.35	-0.82	2.88	2.16	-1.54	-1.54	-1.55	-8.56	-12.53	-27.97	-11.39	-24.87	-32.98	-5.69	-17.00	-32.68	-15.45	-25.99	-26.89
0.0560	-28.58	-35.85	-1.05	1.93	2.85	-1.52	-1.52	-1.53	-8.54	-12.63	-26.45	-11.66	-23.18	-31.42	-5.34	-16.29	-31.25	-15.09	-24.49	-25.78
0.0647	-27.24	-34.38	-1.22	1.10	3.60	-1.51	-1.51	-1.52	-8.52	-12.76	-25.00	-11.97	-21.67	-29.91	-5.08	-15.69	-29.86	-14.77	-23.17	-24.73
0.0733	-25.97	-32.98	-1.34	0.42	4.36	-1.51	-1.51	-1.51	-8.52	-12.90	-23.67	-12.27	-20.33	-28.47	-4.90	-15.18	-28.53	-14.49	-22.01	-23.77
0.0820	-24.80	-31.67	-1.41	-0.10	5.08	-1.51	-1.51	-1.51	-8.51	-13.02	-22.46	-12.53	-19.17	-27.15	-4.77	-14.78	-27.29	-14.26	-21.01	-22.92
0.0907	-23.75	-30.50	-1.46	-0.49	5.73	-1.51	-1.51	-1.51	-8.51	-13.13	-21.38	-12.76	-18.18	-25.96	-4.68	-14.46	-26.18	-14.07	-20.18	-22.19
0.0993	-22.82	-29.46	-1.48	-0.77	6.29	-1.51	-1.51	-1.51	-8.51	-13.21	-20.45	-12.94	-17.35	-24.91	-4.62	-14.21	-25.20	-13.93	-19.48	-21.56
0.1080	-22.01	-28.56	-1.50	-0.98	6.76	-1.51	-1.51	-1.51	-8.51	-13.28	-19.65	-13.08	-16.67	-24.00	-4.59	-14.02	-24.35	-13.82	-18.92	-21.05

Table 6. Comparison of Strategies

Strategy	Probability of Conformance (Joint)	Effective Procurement Cost at PNW (c/bu)
Base Case	0.28	500
Wheat and Protein 13%	0.15	500
Wheat and Protein 14%	0.26	498
Wheat and Protein 15%	0.36	505
Variety		
V1	0.17	510
V2	0.38	499
V3	0.18	510
V4	0.14	512
V5	0.20	509
V6	0.59	488
V7	0.26	505
V8	0.31	503
Location		
L1	0.28	536
L2	0.28	544
L3	0.33	498
L4	0.45	492
L5	0.33	499
L6	0.28	501
L7	0.28	501
L8	0.28	501
L9	0.28	508
L10	0.43	512
L11	0.21	537
L12	0.39	511
L13	0.11	537
L14	0.23	541
L15	0.28	508
L16	0.28	521
L17	0.28	539
L18	0.33	518
L19	0.13	538
L20	0.28	533
Functional Tests		
Absorption	0.52	487
Farinograph	0.68	479
Loaf Volume	0.32	479

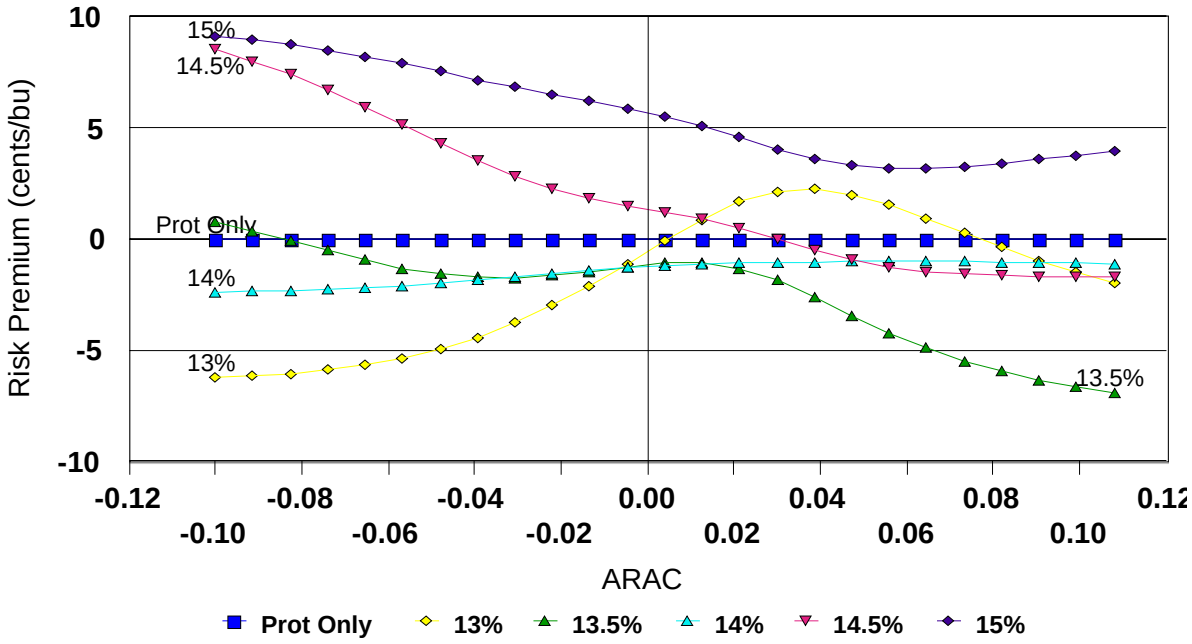

Figure 2. Negative Exponential Utility Weighted Risk Premium Relative to Base Case, by Protein Level and ARAC

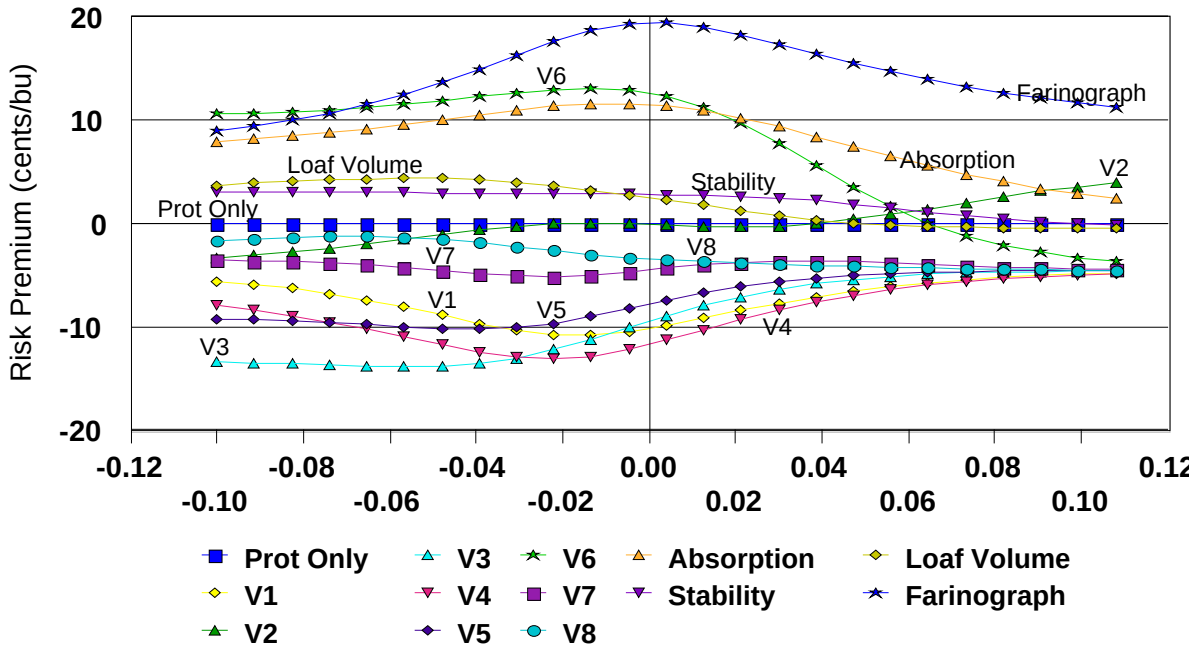

Figure 3. Relationship Between ARAC and Negative Exponential Utility Weighted Risk Premium Relative to Protein Only (Variety vs. Functional Traits)

Location and Wheat Characteristics

The effect of buying based on wheat characteristics and location was examined. Wheat was assumed purchased by location, a location verification test cost of $100/sample was applied, and it was assumed that one sample was taken for every two rail cars. A location specification cost was added for monitoring (IP) each location. This test is envisioned as a cost of auditing, which is common in IP transactions.

The greatest probability of meeting all functional requirements are in locations L4, L10, and L12, respectively (Table 6). The lowest probabilities of meeting functional requirements are found in locations L13, L19, and L11. Low probabilities were affected by stability and loaf volume in L13, stability in L11, and low absorption in L19. In fact, L19 had a higher probability of meeting loaf volume than did any other location. Finally, depending on the procurement practices, end-users may only consider one or a few functional characteristics when making a purchase. The minimum cost strategy, while meeting all requirements with a probability of at least 0.4, is to buy from either locations L4 or L10. Wheat from L3 to L8 have a much lower cost than L10 when shipped to the PNW.

Stochastic dominance analysis of purchase by location strategies indicated preferences varied by risk attitude.[4] The only locations having risk premiums greater than the protein only strategy for any ARAC were locations L3, L4, and L5. L4 was the most preferred set for risk preferring to moderately risk averse decision makers (ARAC= -.1 to +.04), while it was the third preferred set for highly risk averse decision makers. Risk premiums by location indicated the degree of preference for L4 and L5 were limited. L4 is preferred relative to protein only by 5 c/bu for the most risk preferring decision makers and increases to 7.55 c/bu for slightly risk preferring growers and then declines to -.98 c/bu for highly risk averse decision makers (Figure 4). In contrast, the protein only strategy is preferred to L5 by 0.64 c/bu for the most risk preferring decision makers and then increases to 6.76 c/bu for the most risk averse decision makers. Other locations all had risk premiums that were less than protein only and generally tended to become more negative as risk aversion shifted from the most risk averse to most risk preferring.

Variety by Location

A more specific purchase strategy would be to purchase both by variety and location. Specific variety by location purchase strategies were evaluated by comparing purchasing of the various varieties for a given location and comparing purchase of a variety across locations. Since the variety by location combinations produce a large volume of results, only specific comparisons are shown for illustration purposes.

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[4] An illustration of the distributions utilized for stochastic dominance and stochastic efficiency analysis of location strategies is shown in Appendix Figure 2.

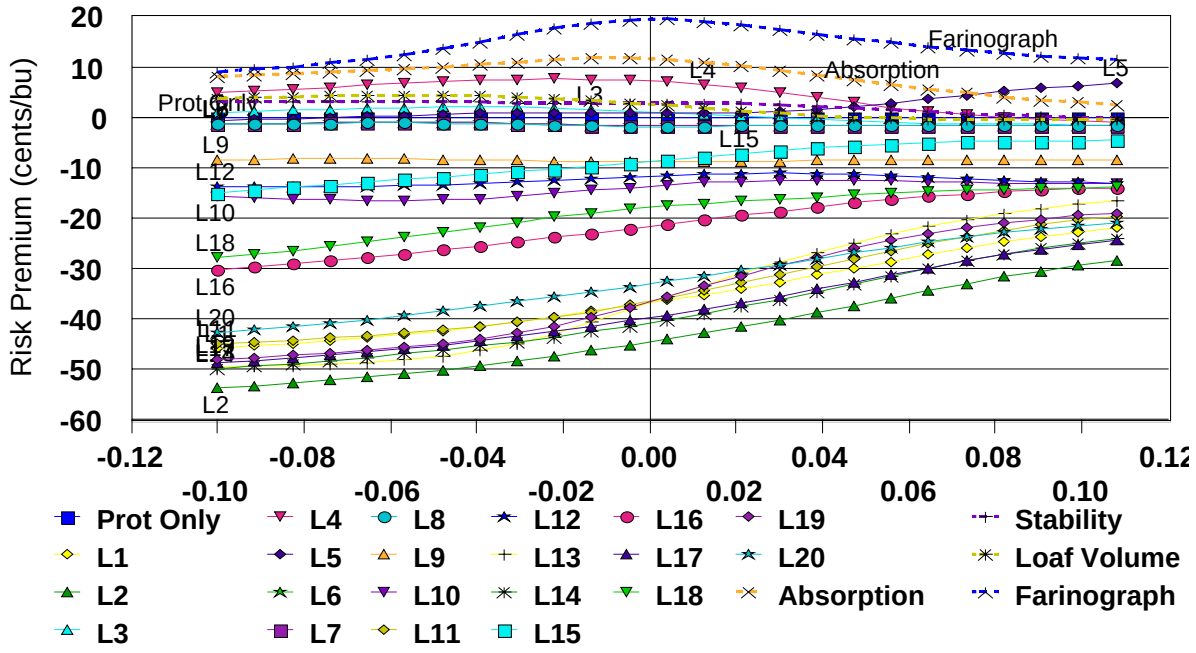

Figure 4. Risk Premium of Purchase Strategies by Location to PNW Relative to Base Case: Protein Only

In location L5, purchase by variety was compared with the protein only strategy (Figure 5, Table 7). Risk premiums for varieties V6 and V8 were positive across the range of risk attitudes, indicating purchase of these two varieties in L5 would be preferred to a protein only strategy irregardless of the risk attitude of the buyer. V6 has the highest risk premiums, which ranged from 4.86 c/bu for the most risk averse buyers, to a high of 14.37 c/bu for risk neutral buyers and then falling again to 9.63 c/bu for the most risk preferring buyers. For variety V8, risk premiums were lower at all risk attitudes than V6 and were lowest for the most risk preferring buyers
(1.23 c/bu) and highest for the most risk averse buyers (4.20 c/bu). For the remaining varieties, all except for variety V4 had negative risk premiums for all but the most risk averse buyers. These varieties all had risk premiums for the most risk averse buyers of 1.93 to 2.33 c/bu. Variety V4 in location L5 had risk premiums that were negative across the range of risk attitudes indicating that this would be dominated by a protein only strategy across the range of risk attitudes.

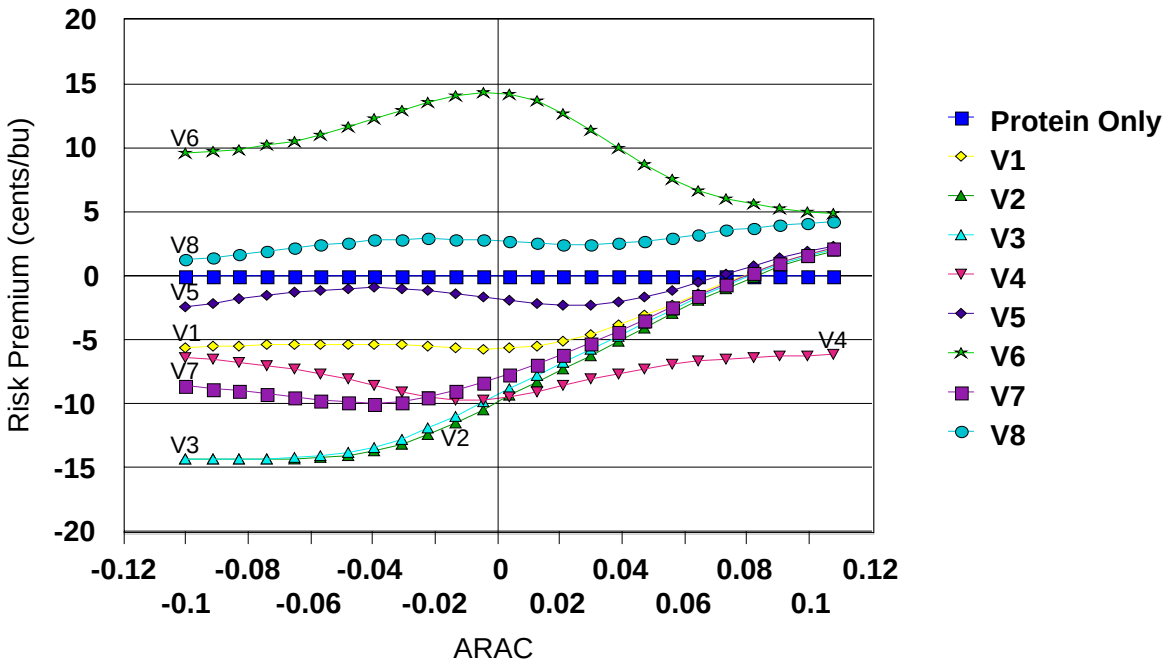

Figure 5. Purchase by Variety for Location L5, by ARAC

Purchase by variety for specific locations was also examined for other locations; however, only varieties in locations L3 to L9 and L15 had positive values the risk premium over protein only for any of the variety strategies (Tables 8 to 15). However, unlike Location L5, none of the individual variety strategies in the other locations had positive risk premiums across the entire range of risk attitudes and for most locations had equal to lower risk premiums than for location L5. Most variety strategies that had positive risk premiums were largest for risk neutral to slightly risk preferring buyers and were largely for varieties V6, V8, V5, and for highly risk averse buyers for variety V2.

Purchase for variety V6 was then compared across locations (Figure 6). It is notable that while purchase for variety V6 has the highest risk premium of all varieties in location L5, for several locations, variety V6 has a large negative risk premium (locations L1, L2, L11, L13, L14, L17, and L20). This indicates that purchasing strategies that focus on variety V6 do not perform similarly across locations when compared to purchasing only on protein. For risk averse buyers, variety V6 in location L5 (4.86 c/bu) is preferred. All other locations have negative risk premiums. For risk neutral buyers, variety V6 in locations L5 would be preferred (14.23 c/bu); however, locations L3, L4, L6 to L9, and L15 also have positive risk premiums. For risk preferring buyers, variety V6 is preferred in location L6 (9.78 c/bu), but is also positive in locations L3 to L9.

Table 7. Risk Premiums for Purchase of Specific Variety in Location L5, by ARAC

ARAC	ProtOnly	V1	V2	V3	V4	V5	V6	V7	V8
-0.1000	-	-5.61	-14.35	-14.34	-6.44	-2.38	9.63	-8.59	1.23
-0.0913	-	-5.55	-14.33	-14.31	-6.58	-2.11	9.71	-8.78	1.45
-0.0827	-	-5.48	-14.32	-14.29	-6.76	-1.83	9.89	-8.99	1.68
-0.0740	-	-5.42	-14.31	-14.26	-6.99	-1.57	10.16	-9.22	1.92
-0.0653	-	-5.36	-14.28	-14.20	-7.28	-1.33	10.53	-9.46	2.16
-0.0567	-	-5.32	-14.20	-14.07	-7.65	-1.13	11.01	-9.69	2.39
-0.0480	-	-5.31	-14.02	-13.82	-8.09	-1.00	11.58	-9.87	2.59
-0.0393	-	-5.34	-13.69	-13.40	-8.58	-0.95	12.24	-9.94	2.75
-0.0307	-	-5.42	-13.16	-12.77	-9.06	-1.02	12.93	-9.83	2.85
-0.0220	-	-5.54	-12.42	-11.93	-9.45	-1.18	13.60	-9.51	2.89
-0.0133	-	-5.66	-11.49	-10.93	-9.66	-1.42	14.12	-8.98	2.85
-0.0047	-	-5.71	-10.44	-9.86	-9.65	-1.70	14.37	-8.32	2.76
0.0040	-	-5.65	-9.37	-8.79	-9.41	-1.97	14.23	-7.61	2.64
0.0127	-	-5.44	-8.31	-7.76	-9.03	-2.19	13.66	-6.86	2.52
0.0213	-	-5.08	-7.26	-6.77	-8.56	-2.31	12.66	-6.09	2.45
0.0300	-	-4.55	-6.21	-5.77	-8.08	-2.29	1.38	-5.27	2.46
0.0387	-	-3.89	-5.15	-4.75	-7.63	-2.08	9.97	-4.38	2.56
0.0473	-	-3.11	-4.07	-3.71	-7.24	-1.70	8.64	-3.44	2.74
0.0560	-	-2.26	-3.00	-2.68	-6.92	-1.16	7.52	-2.46	2.98
0.0647	-	-1.38	-1.95	-1.66	-6.67	-0.53	6.64	-1.50	3.25
0.0733	-	-0.52	-0.96	-0.72	-6.48	0.13	6.01	-0.58	3.52
0.0820	-	0.28	-0.07	0.14	-6.35	0.78	5.56	0.26	3.76
0.0907	-	0.99	0.71	0.90	-6.26	1.38	5.25	0.99	3.96
0.0993	-	1.60	1.38	1.53	-6.20	1.90	5.03	1.61	4.11
0.1080	-	2.10	1.93	2.05	-6.16	2.33	4.86	2.12	4.20

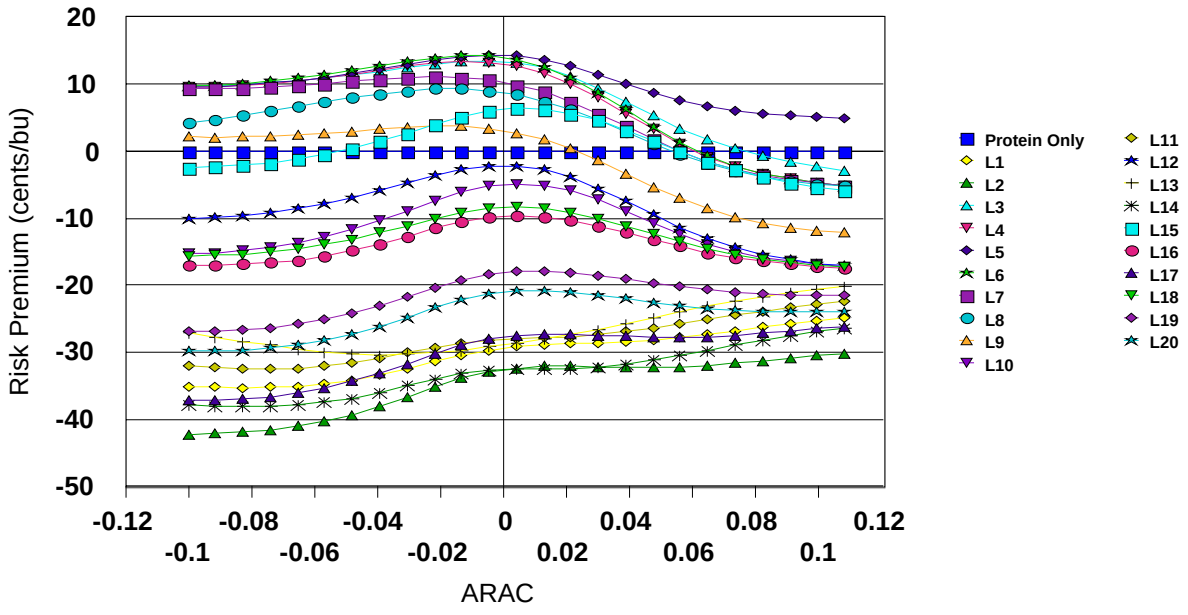

Figure 6. Purchase by Location for Variety V6, by ARAC

Table 8. Risk Premiums for Purchase of Variety V1 by Location, by ARAC

ARAC	Prot Only	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18	L19	L20
-0.1000	-	-55.36	-61.65	-2.78	-3.06	-5.61	0.25	-7.28	-26.56	-14.43	-21.13	-52.98	-21.87	-49.29	-58.78	-19.37	-37.80	-55.73	-34.61	-45.45	-50.68
-0.0913	-	-55.33	-61.45	-2.59	-3.09	-5.55	0.24	-7.53	-26.98	-14.69	-21.59	-52.64	-22.01	-49.21	-58.39	-18.99	-37.48	-55.39	-34.15	-44.82	-50.30
-0.0827	-	-55.27	-61.20	-2.42	-3.15	-5.48	0.20	-7.82	-27.29	-14.99	-22.07	-52.27	-22.14	-49.13	-57.95	-18.59	-37.14	-54.99	-33.65	-44.14	-49.89
-0.0740	-	-55.17	-60.88	-2.28	-3.27	-5.42	0.12	-8.16	-27.42	-15.36	-22.56	-51.87	-22.25	-49.05	-57.46	-18.18	-36.78	-54.50	-33.12	-43.39	-49.44
-0.0653	-	-55.01	-60.49	-2.20	-3.46	-5.36	-0.02	-8.55	-27.32	-15.78	-23.03	-51.44	-22.35	-48.97	-56.92	-17.76	-36.39	-53.94	-32.55	-42.60	-48.95
-0.0567	-	-54.75	-60.01	-2.20	-3.74	-5.32	-0.23	-8.99	-26.92	-16.25	-23.44	-50.95	-22.44	-48.84	-56.31	-17.35	-35.96	-53.29	-31.95	-41.75	-48.39
-0.0480	-	-54.37	-59.43	-2.31	-4.11	-5.31	-0.51	-9.47	-26.19	-16.76	-23.76	-50.39	-22.49	-48.61	-55.62	-16.95	-35.48	-52.55	-31.31	-40.87	-47.76
-0.0393	-	-53.78	-58.71	-2.55	-4.57	-5.34	-0.86	-9.95	-25.08	-17.27	-23.93	-49.70	-22.50	-48.15	-54.80	-16.57	-34.90	-51.72	-30.62	-39.96	-47.02
-0.0307	-	-52.91	-57.81	-2.93	-5.07	-5.42	-1.24	-10.37	-23.59	-17.69	-23.89	-48.81	-22.42	-47.34	-53.82	-16.20	-34.19	-50.77	-29.86	-39.03	-46.12
-0.0220	-	-51.69	-56.70	-3.40	-5.51	-5.54	-1.62	-10.62	-21.78	-17.93	-23.63	-47.66	-22.21	-46.08	-52.64	-15.79	-33.28	-49.71	-29.01	-38.08	-45.03
-0.0133	-	-50.12	-55.37	-3.88	-5.79	-5.66	-1.93	-10.63	-19.77	-17.90	-23.15	-46.24	-21.82	-44.36	-51.24	-15.32	-32.16	-48.53	-28.08	-37.11	-43.73
-0.0047	-	-48.28	-53.85	-4.32	-5.82	-5.71	-2.14	-10.37	-17.68	-17.59	-22.48	-44.58	-21.25	-42.30	-49.66	-14.73	-30.87	-47.24	-27.07	-36.09	-42.26
0.0040	-	-46.29	-52.20	-4.66	-5.63	-5.65	-2.25	-9.88	-15.67	-17.05	-21.71	-42.79	-20.54	-40.09	-47.96	-14.03	-29.45	-45.86	-26.03	-35.03	-40.67
0.0127	-	-44.24	-50.47	-4.91	-5.32	-5.44	-2.30	-9.27	-13.82	-16.39	-20.88	-40.92	-19.76	-37.84	-46.17	-13.25	-27.99	-44.40	-24.99	-33.92	-39.03
0.0213	-	-42.18	-48.68	-5.09	-4.98	-5.08	-2.36	-8.63	-12.18	-15.72	-20.06	-39.03	-19.01	-35.65	-44.34	-12.44	-26.54	-42.88	-23.97	-32.76	-37.38
0.0300	-	-40.15	-46.85	-5.24	-4.73	-4.55	-2.49	-8.04	-10.76	-15.10	-19.29	-37.16	-18.35	-33.55	-42.49	-11.65	-25.15	-41.30	-23.01	-31.57	-35.74
0.0387	-	-38.17	-45.01	-5.38	-4.61	-3.89	-2.73	-7.54	-9.57	-14.58	-18.65	-35.31	-17.85	-31.56	-40.63	-10.95	-23.87	-39.69	-22.12	-30.37	-34.15
0.0473	-	-36.27	-43.19	-5.50	-4.62	-3.11	-3.08	-7.15	-8.61	-14.17	-18.16	-33.53	-17.54	-29.70	-38.78	-10.37	-22.72	-38.08	-21.32	-29.18	-32.63
0.0560	-	-34.47	-41.41	-5.62	-4.75	-2.26	-3.50	-6.86	-7.87	-13.87	-17.84	-31.82	-17.39	-27.98	-36.99	-9.93	-21.72	-36.48	-20.63	-28.04	-31.23
0.0647	-	-32.81	-39.72	-5.72	-4.95	-1.38	-3.95	-6.64	-7.32	-13.65	-17.66	-30.22	-17.37	-26.43	-35.29	-9.61	-20.89	-34.95	-20.05	-26.96	-29.95
0.0733	-	-31.29	-38.14	-5.81	-5.16	-0.52	-4.37	-6.49	-6.93	-13.49	-17.60	-28.76	-17.43	-25.05	-33.70	-9.40	-20.21	-33.52	-19.58	-25.99	-28.82
0.0820	-	-29.93	-36.71	-5.88	-5.35	0.28	-4.75	-6.38	-6.65	-13.38	-17.61	-27.44	-17.52	-23.85	-32.25	-9.26	-19.68	-32.20	-19.20	-25.13	-27.83
0.0907	-	-28.74	-35.43	-5.93	-5.52	0.99	-5.05	-6.30	-6.47	-13.30	-17.65	-26.29	-17.62	-22.83	-30.96	-9.18	-19.26	-31.02	-18.91	-24.39	-27.00
0.0993	-	-27.70	-34.31	-5.97	-5.65	1.60	-5.30	-6.24	-6.34	-13.24	-17.71	-25.28	-17.72	-21.97	-29.82	-9.13	-18.95	-29.99	-18.69	-23.77	-26.30
0.1080	-	-26.82	-33.36	-6.00	-5.76	2.10	-5.49	-6.19	-6.26	-13.19	-17.77	-24.43	-17.80	-21.26	-28.84	-9.10	-18.71	-29.09	-18.52	-23.26	-25.73

Table 9. Risk Premiums for Purchase of Variety V2 by Location, by ARAC

ARAC	Prot Only	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18	L19	L20
-0.1000	-	-56.29	-64.22	-12.03	-6.21	-14.35	-1.14	-14.34	-24.23	-21.59	-24.17	-52.66	-26.86	-46.80	-58.55	-25.17	-39.44	-57.65	-36.13	-46.06	-51.49
-0.0913	-	-56.27	-64.18	-11.90	-6.08	-14.33	-0.74	-14.32	-24.70	-21.57	-24.23	-52.77	-26.35	-46.96	-58.63	-25.11	-39.37	-57.39	-35.84	-45.75	-51.54
-0.0827	-	-56.19	-64.08	-11.77	-5.90	-14.32	-0.27	-14.31	-25.16	-21.57	-24.20	-52.85	-25.79	-47.12	-58.67	-25.05	-39.28	-57.05	-35.53	-45.38	-51.53
-0.0740	-	-56.01	-63.89	-11.64	-5.66	-14.31	0.26	-14.30	-25.54	-21.57	-24.02	-52.90	-25.16	-47.26	-58.66	-24.96	-39.15	-56.62	-35.16	-44.93	-51.45
-0.0653	-	-55.71	-63.57	-11.50	-5.36	-14.28	0.88	-14.27	-25.80	-21.55	-23.68	-52.87	-24.45	-47.35	-58.57	-24.82	-38.96	-56.06	-34.73	-44.37	-51.25
-0.0567	-	-55.24	-63.08	-11.32	-5.00	-14.20	1.56	-14.18	-25.82	-21.49	-23.14	-52.70	-23.65	-47.33	-58.33	-24.58	-38.65	-55.35	-34.20	-43.68	-50.89
-0.0480	-	-54.52	-62.35	-11.08	-4.57	-14.02	2.31	-14.00	-25.52	-21.34	-22.38	-52.32	-22.77	-47.12	-57.87	-24.16	-38.14	-54.44	-33.51	-42.84	-50.28
-0.0393	-	-53.50	-61.31	-10.73	-4.12	-13.69	3.07	-13.67	-24.80	-21.02	-21.40	-51.60	-21.82	-46.58	-57.07	-23.48	-37.34	-53.32	-32.62	-41.82	-49.36
-0.0307	-	-52.12	-59.90	-10.23	-3.69	-13.16	3.75	-13.15	-23.60	-20.49	-20.27	-50.43	-20.86	-45.60	-55.84	-22.47	-36.20	-51.95	-31.48	-40.61	-48.07
-0.0220	-	-50.37	-58.14	-9.59	-3.35	-12.42	4.26	-12.40	-21.96	-19.72	-19.09	-48.79	-19.95	-44.09	-54.15	-21.13	-34.68	-50.36	-30.10	-39.21	-46.40
-0.0133	-	-48.35	-56.10	-8.83	-3.16	-11.49	4.50	-11.48	-20.00	-18.75	-18.00	-46.73	-19.17	-42.13	-52.05	-19.54	-32.88	-48.58	-28.55	-37.68	-44.43
-0.0047	-	-46.17	-53.91	-8.04	-3.11	-10.44	4.44	-10.44	-17.89	-17.66	-17.08	-44.43	-18.54	-39.88	-49.72	-17.82	-30.92	-46.72	-26.94	-36.07	-42.31
0.0040	-	-43.96	-51.69	-7.26	-3.14	-9.37	4.16	-9.37	-15.78	-16.54	-16.37	-42.05	-18.04	-37.51	-47.33	-16.09	-28.93	-44.83	-25.36	-34.46	-40.16
0.0127	-	-41.79	-49.51	-6.51	-3.16	-8.31	3.78	-8.31	-13.74	-15.43	-15.78	-39.72	-17.56	-35.16	-44.98	-14.42	-27.00	-42.96	-23.85	-32.84	-38.05
0.0213	-	-39.69	-47.41	-5.77	-3.10	-7.26	3.40	-7.26	-11.80	-14.35	-15.24	-37.47	-17.05	-32.87	-42.71	-12.83	-25.13	-41.10	-22.38	-31.23	-36.00
0.0300	-	-37.65	-45.37	-5.00	-2.89	-6.21	3.09	-6.21	-9.94	-13.28	-14.65	-35.30	-16.44	-30.66	-40.54	-11.29	-23.33	-39.27	-20.94	-29.60	-34.01
0.0387	-	-35.69	-43.42	-4.18	-2.53	-5.15	2.88	-5.15	-8.15	-12.19	-14.01	-33.21	-15.74	-28.52	-38.46	-9.80	-21.58	-37.47	-19.51	-27.96	-32.08
0.0473	-	-33.81	-41.55	-3.30	-2.02	-4.07	2.77	-4.07	-6.43	-11.10	-13.31	-31.20	-14.94	-26.46	-36.47	-8.36	-19.89	-35.71	-18.10	-26.32	-30.22
0.0560	-	-32.03	-39.78	-2.38	-1.39	-3.00	2.78	-3.00	-4.81	-10.01	-12.57	-29.28	-14.08	-24.49	-34.60	-6.99	-18.27	-34.04	-16.72	-24.71	-28.43
0.0647	-	-30.37	-38.14	-1.46	-0.70	-1.95	2.87	-1.95	-3.31	-8.96	-11.84	-27.47	-13.21	-22.64	-32.85	-5.71	-16.76	-32.47	-15.41	-23.16	-26.75
0.0733	-	-28.85	-36.64	-0.58	0.00	-0.96	3.01	-0.96	-1.97	-7.97	-11.15	-25.81	-12.37	-20.93	-31.24	-4.54	-15.37	-31.03	-14.20	-21.70	-25.18
0.0820	-	-27.48	-35.29	0.24	0.67	-0.07	3.19	-0.07	-0.79	-7.07	-10.52	-24.31	-11.60	-19.37	-29.80	-3.51	-14.12	-29.74	-13.11	-20.36	-23.76
0.0907	-	-26.28	-34.11	0.96	1.28	0.71	3.37	0.71	0.20	-6.29	-9.98	-22.98	-10.91	-17.98	-28.53	-2.62	-13.02	-28.61	-12.15	-19.16	-22.48
0.0993	-	-25.24	-33.08	1.57	1.81	1.38	3.53	1.38	1.02	-5.62	-9.52	-21.82	-10.32	-16.76	-27.44	-1.87	-12.08	-27.64	-11.34	-18.10	-21.37
0.1080	-	-24.35	-32.22	2.08	2.26	1.93	3.66	1.93	1.68	-5.07	-9.15	-20.83	-9.84	-15.71	-26.50	-1.26	-11.29	-26.81	-10.66	-17.18	-20.40

Table 10. Risk Premiums for Purchase of Variety V3 by Location, by ARAC

ARAC	Prot Only	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18	L19	L20
-0.1000	-	-62.61	-67.74	-12.22	-5.59	-14.34	-1.20	-15.19	-25.64	-22.46	-24.15	-56.32	-26.45	-55.66	-62.14	-25.35	-41.68	-60.60	-37.75	-48.97	-55.13
-0.0913	-	-62.26	-67.41	-12.13	-5.51	-14.31	-0.84	-15.31	-26.14	-22.57	-24.22	-56.12	-26.01	-55.53	-61.90	-25.32	-41.54	-60.10	-37.45	-48.46	-54.87
-0.0827	-	-61.86	-67.02	-12.06	-5.42	-14.29	-0.43	-15.44	-26.58	-22.72	-24.19	-55.90	-25.54	-55.38	-61.63	-25.28	-41.38	-59.54	-37.13	-47.91	-54.57
-0.0740	-	-61.39	-66.56	-12.00	-5.32	-14.26	0.02	-15.59	-26.90	-22.88	-24.04	-55.63	-25.03	-55.15	-61.30	-25.22	-41.18	-58.90	-36.76	-47.29	-54.21
-0.0653	-	-60.79	-65.98	-11.92	-5.20	-14.20	0.50	-15.71	-27.04	-23.02	-23.77	-55.29	-24.48	-54.82	-60.89	-25.10	-40.91	-58.16	-36.35	-46.60	-53.74
-0.0567	-	-60.04	-65.27	-11.80	-5.08	-14.07	1.02	-15.77	-26.92	-23.10	-23.35	-54.81	-23.89	-54.30	-60.35	-24.86	-40.51	-57.31	-35.84	-45.82	-53.13
-0.0480	-	-59.06	-64.34	-11.59	-4.95	-13.82	1.53	-15.69	-26.45	-23.04	-22.77	-54.12	-23.27	-53.49	-59.60	-24.41	-39.92	-56.32	-35.19	-44.91	-52.32
-0.0393	-	-57.76	-63.15	-11.22	-4.84	-13.40	1.99	-15.41	-25.56	-22.77	-22.07	-53.13	-22.62	-52.26	-58.54	-23.68	-39.05	-55.13	-34.34	-43.86	-51.22
-0.0307	-	-56.10	-61.63	-10.67	-4.77	-12.77	2.32	-14.86	-24.23	-22.22	-21.29	-51.73	-21.99	-50.54	-57.10	-22.61	-37.83	-53.73	-33.24	-42.63	-49.79
-0.0220	-	-54.05	-59.77	-9.92	-4.77	-11.93	2.44	-14.04	-22.50	-21.37	-20.49	-49.90	-21.41	-48.31	-55.25	-21.20	-36.24	-52.11	-31.89	-41.20	-48.00
-0.0133	-	-51.71	-57.63	-9.04	-4.86	-10.93	2.31	-13.01	-20.49	-20.29	-19.76	-47.71	-20.91	-45.70	-53.05	-19.55	-34.36	-50.29	-30.33	-39.62	-45.94
-0.0047	-	-49.22	-55.35	-8.13	-5.01	-9.86	1.95	-11.87	-18.37	-19.09	-19.15	-45.31	-20.49	-42.90	-50.65	-17.81	-32.34	-48.36	-28.68	-37.94	-43.74
0.0040	-	-46.72	-53.04	-7.29	-5.18	-8.79	1.44	-10.73	-16.27	-17.90	-18.66	-42.89	-20.13	-40.11	-48.23	-16.11	-30.31	-46.41	-27.06	-36.24	-41.52
0.0127	-	-44.32	-50.79	-6.56	-5.34	-7.76	0.86	-9.67	-14.31	-16.79	-18.25	-40.54	-19.78	-37.46	-45.87	-14.52	-28.37	-44.48	-25.53	-34.58	-39.39
0.0213	-	-42.06	-48.64	-5.95	-5.45	-6.77	0.24	-8.73	-12.53	-15.82	-17.91	-38.33	-19.43	-35.00	-43.64	-13.06	-26.59	-42.62	-24.14	-33.00	-37.38
0.0300	-	-39.94	-46.59	-5.42	-5.54	-5.77	-0.43	-7.93	-10.97	-14.99	-17.62	-36.26	-19.09	-32.74	-41.53	-11.76	-24.98	-40.83	-22.92	-31.50	-35.52
0.0387	-	-37.95	-44.63	-4.97	-5.61	-4.75	-1.15	-7.29	-9.64	-14.32	-17.42	-34.32	-18.78	-30.68	-39.53	-10.60	-23.57	-39.12	-21.86	-30.11	-33.82
0.0473	-	-36.09	-42.77	-4.59	-5.67	-3.71	-1.92	-6.81	-8.56	-13.83	-17.31	-32.52	-18.52	-28.80	-37.66	-9.62	-22.37	-37.48	-20.97	-28.83	-32.27
0.0560	-	-34.36	-41.02	-4.30	-5.73	-2.68	-2.70	-6.47	-7.73	-13.49	-17.29	-30.85	-18.33	-27.13	-35.91	-8.81	-21.37	-35.93	-20.26	-27.68	-30.89
0.0647	-	-32.76	-39.38	-4.09	-5.80	-1.66	-3.42	-6.26	-7.13	-13.27	-17.34	-29.33	-18.20	-25.65	-34.29	-8.20	-20.57	-34.48	-19.69	-26.64	-29.66
0.0733	-	-31.31	-37.87	-3.96	-5.86	-0.72	-4.05	-6.14	-6.72	-13.15	-17.43	-27.97	-18.13	-24.36	-32.80	-7.75	-19.94	-33.13	-19.26	-25.72	-28.59
0.0820	-	-30.00	-36.51	-3.90	-5.91	0.14	-4.56	-6.08	-6.45	-13.08	-17.53	-26.76	-18.08	-23.26	-31.46	-7.46	-19.45	-31.90	-18.94	-24.93	-27.67
0.0907	-	-28.84	-35.29	-3.91	-5.95	0.90	-4.96	-6.05	-6.28	-13.05	-17.64	-25.70	-18.06	-22.33	-30.28	-7.30	-19.09	-30.80	-18.70	-24.24	-26.89
0.0993	-	-27.83	-34.22	-3.96	-5.98	1.53	-5.26	-6.04	-6.18	-13.04	-17.73	-24.79	-18.05	-21.56	-29.24	-7.23	-18.81	-29.83	-18.52	-23.67	-26.23
0.1080	-	-26.95	-33.30	-4.04	-6.01	2.05	-5.48	-6.04	-6.13	-13.04	-17.80	-24.02	-18.05	-20.94	-28.35	-7.22	-18.61	-28.98	-18.39	-23.19	-25.69

Table 11. Risk Premiums for Purchase of Variety V4 by Location, by ARAC

ARAC	Prot Only	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18	L19	L20
-0.1000	-	-58.93	-65.90	-4.44	-5.05	-6.44	-3.10	-8.60	-27.05	-15.74	-23.01	-57.42	-23.53	-55.22	-63.07	-21.73	-39.81	-60.14	-36.89	-48.07	-53.23
-0.0913	-	-58.75	-65.63	-4.45	-5.40	-6.58	-3.32	-9.11	-27.63	-16.26	-23.79	-57.36	-24.00	-55.32	-62.95	-21.51	-39.71	-59.75	-36.65	-47.64	-53.02
-0.0827	-	-58.55	-65.32	-4.52	-5.83	-6.76	-3.60	-9.70	-28.11	-16.88	-24.66	-57.27	-24.53	-55.39	-62.79	-21.28	-39.62	-59.33	-36.39	-47.18	-52.80
-0.0740	-	-58.34	-64.98	-4.67	-6.37	-6.99	-3.95	-10.40	-28.44	-17.60	-25.57	-57.14	-25.09	-55.38	-62.59	-21.07	-39.53	-58.86	-36.14	-46.70	-52.56
-0.0653	-	-58.09	-64.60	-4.93	-7.01	-7.28	-4.38	-11.19	-28.54	-18.42	-26.50	-56.93	-25.68	-55.25	-62.32	-20.86	-39.43	-58.34	-35.87	-46.20	-52.29
-0.0567	-	-57.78	-64.14	-5.32	-7.74	-7.65	-4.86	-12.04	-28.32	-19.31	-27.38	-56.61	-26.26	-54.94	-61.92	-20.67	-39.29	-57.75	-35.59	-45.68	-51.95
-0.0480	-	-57.34	-63.56	-5.86	-8.53	-8.09	-5.37	-12.89	-27.72	-20.20	-28.12	-56.09	-26.76	-54.33	-61.35	-20.48	-39.06	-57.07	-35.26	-45.13	-51.50
-0.0393	-	-56.69	-62.79	-6.54	-9.28	-8.58	-5.85	-13.64	-26.67	-20.98	-28.60	-55.27	-27.08	-53.31	-60.50	-20.28	-38.64	-56.25	-34.84	-44.51	-50.85
-0.0307	-	-55.71	-61.75	-7.32	-9.86	-9.06	-6.24	-14.14	-25.16	-21.49	-28.69	-54.05	-27.12	-51.80	-59.27	-20.02	-37.93	-55.24	-34.26	-43.77	-49.92
-0.0220	-	-54.33	-60.38	-8.06	-10.15	-9.45	-6.46	-14.26	-23.24	-21.59	-28.33	-52.38	-26.78	-49.77	-57.62	-19.62	-36.86	-53.98	-33.43	-42.83	-48.63
-0.0133	-	-52.56	-58.68	-8.62	-10.05	-9.66	-6.46	-13.95	-21.06	-21.23	-27.57	-50.31	-26.05	-47.33	-55.59	-19.02	-35.44	-52.46	-32.34	-41.66	-47.01
-0.0047	-	-50.49	-56.75	-8.91	-9.61	-9.65	-6.27	-13.27	-18.79	-20.49	-26.51	-47.98	-25.03	-44.66	-53.30	-18.21	-33.75	-50.75	-31.02	-40.29	-45.15
0.0040	-	-48.28	-54.69	-8.92	-8.95	-9.41	-5.96	-12.37	-16.62	-19.54	-25.31	-45.55	-23.86	-41.96	-50.91	-17.20	-31.95	-48.91	-29.58	-38.77	-43.17
0.0127	-	-46.03	-52.60	-8.73	-8.21	-9.03	-5.59	-11.39	-14.64	-18.52	-24.06	-43.15	-22.66	-39.35	-48.53	-16.09	-30.14	-47.03	-28.11	-37.18	-41.19
0.0213	-	-43.81	-50.52	-8.42	-7.50	-8.56	-5.25	-10.45	-12.90	-17.54	-22.86	-40.83	-21.52	-36.87	-46.22	-14.95	-28.41	-45.14	-26.67	-35.57	-39.26
0.0300	-	-41.64	-48.47	-8.05	-6.90	-8.08	-4.98	-9.60	-11.41	-16.66	-21.74	-38.61	-20.52	-34.55	-43.98	-13.84	-26.78	-43.26	-25.30	-33.97	-37.39
0.0387	-	-39.55	-46.45	-7.68	-6.43	-7.63	-4.81	-8.87	-10.16	-15.91	-20.75	-36.50	-19.69	-32.37	-41.83	-12.82	-25.28	-41.39	-24.04	-32.40	-35.61
0.0473	-	-37.53	-44.47	-7.34	-6.12	-7.24	-4.76	-8.25	-9.14	-15.27	-19.92	-34.50	-19.05	-30.36	-39.78	-11.93	-23.93	-39.56	-22.89	-30.89	-33.93
0.0560	-	-35.62	-42.57	-7.04	-5.93	-6.92	-4.81	-7.74	-8.33	-14.75	-19.26	-32.63	-18.59	-28.51	-37.82	-11.19	-22.75	-37.78	-21.89	-29.47	-32.36
0.0647	-	-33.84	-40.76	-6.79	-5.83	-6.67	-4.92	-7.33	-7.71	-14.34	-18.78	-30.90	-18.29	-26.85	-35.99	-10.60	-21.74	-36.09	-21.04	-28.15	-30.93
0.0733	-	-32.21	-39.08	-6.60	-5.81	-6.48	-5.08	-7.01	-7.24	-14.02	-18.45	-29.32	-18.11	-25.38	-34.29	-10.15	-20.90	-34.51	-20.34	-26.96	-29.65
0.0820	-	-30.74	-37.54	-6.45	-5.82	-6.35	-5.25	-6.76	-6.90	-13.77	-18.24	-27.91	-18.02	-24.11	-32.76	-9.82	-20.22	-33.07	-19.77	-25.91	-28.53
0.0907	-	-29.44	-36.17	-6.33	-5.85	-6.26	-5.40	-6.58	-6.66	-13.58	-18.11	-26.68	-17.97	-23.02	-31.39	-9.58	-19.68	-31.77	-19.33	-25.02	-27.58
0.0993	-	-28.31	-34.97	-6.25	-5.88	-6.20	-5.54	-6.44	-6.48	-13.44	-18.04	-25.61	-17.96	-22.12	-30.19	-9.42	-19.26	-30.63	-18.99	-24.27	-26.77
0.1080	-	-27.33	-33.93	-6.20	-5.92	-6.16	-5.65	-6.33	-6.36	-13.33	-18.00	-24.69	-17.97	-21.37	-29.15	-9.30	-18.94	-29.64	-18.74	-23.65	-26.11

Table 12. Risk Premiums for Purchase of Variety V5 by Location, by ARAC

ARAC	Prot Only	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18	L19	L20
-0.1000	-	-52.08	-56.66	-0.86	0.49	-2.38	3.69	-2.60	-11.99	-10.25	-19.34	-47.42	-18.77	-47.14	-52.97	-16.52	-32.63	-49.53	-28.73	-40.46	-45.44
-0.0913	-	-51.61	-56.13	-0.61	0.96	-2.11	4.19	-2.39	-11.91	-10.05	-19.29	-46.93	-18.36	-46.76	-52.42	-15.95	-32.00	-49.02	-28.19	-39.83	-44.77
-0.0827	-	-51.07	-55.52	-0.35	1.45	-1.83	4.73	-2.19	-11.83	-9.85	-19.14	-46.38	-17.87	-46.34	-51.80	-15.35	-31.31	-48.43	-27.59	-39.13	-44.04
-0.0740	-	-50.46	-54.83	-0.11	1.96	-1.57	5.31	-2.02	-11.77	-9.68	-18.86	-45.78	-17.29	-45.90	-51.11	-14.71	-30.57	-47.77	-26.94	-38.35	-43.23
-0.0653	-	-49.76	-54.04	0.09	2.47	-1.33	5.92	-1.92	-11.73	-9.56	-18.42	-45.11	-16.62	-45.43	-50.34	-14.03	-29.79	-47.03	-26.26	-37.50	-42.36
-0.0567	-	-48.99	-53.16	0.24	2.94	-1.13	6.55	-1.90	-11.72	-9.52	-17.82	-44.40	-15.89	-44.92	-49.51	-13.33	-28.98	-46.22	-25.54	-36.59	-41.42
-0.0480	-	-48.13	-52.20	0.30	3.33	-1.00	7.17	-2.00	-11.74	-9.59	-17.03	-43.67	-15.13	-44.36	-48.65	-12.61	-28.14	-45.36	-24.82	-35.64	-40.44
-0.0393	-	-47.20	-51.21	0.24	3.58	-0.95	7.75	-2.25	-11.78	-9.79	-16.08	-42.94	-14.40	-43.72	-47.79	-11.91	-27.32	-44.49	-24.13	-34.68	-39.44
-0.0307	-	-46.20	-50.21	0.05	3.62	-1.02	8.23	-2.64	-11.80	-10.11	-15.02	-42.24	-13.75	-42.93	-46.97	-11.24	-26.53	-43.64	-23.52	-33.78	-38.47
-0.0220	-	-45.13	-49.25	-0.27	3.43	-1.18	8.56	-3.12	-11.74	-10.51	-13.95	-41.56	-13.27	-41.93	-46.23	-10.65	-25.81	-42.86	-23.00	-32.97	-37.55
-0.0133	-	-43.99	-48.37	-0.68	3.06	-1.42	8.67	-3.62	-11.50	-10.92	-13.01	-40.85	-12.98	-40.66	-45.53	-10.15	-25.15	-42.18	-22.57	-32.29	-36.72
-0.0047	-	-42.80	-47.54	-1.15	2.56	-1.70	8.50	-4.05	-11.04	-11.28	-12.32	-40.06	-12.86	-39.16	-44.80	-9.75	-24.55	-41.55	-22.21	-31.70	-35.94
0.0040	-	-41.57	-46.71	-1.64	2.02	-1.97	7.99	-4.40	-10.38	-11.56	-11.94	-39.11	-12.88	-37.51	-43.97	-9.41	-23.96	-40.91	-21.87	-31.16	-35.18
0.0127	-	-40.31	-45.80	-2.14	1.44	-2.19	7.13	-4.67	-9.61	-11.79	-11.88	-37.99	-13.00	-35.77	-42.97	-9.10	-23.36	-40.20	-21.51	-30.58	-34.39
0.0213	-	-39.00	-44.78	-2.61	0.78	-2.31	5.92	-4.91	-8.82	-11.99	-12.09	-36.71	-13.22	-34.02	-41.78	-8.78	-22.74	-39.36	-21.12	-29.93	-33.53
0.0300	-	-37.64	-43.63	-3.03	0.01	-2.29	4.42	-5.13	-8.08	-12.18	-12.54	-35.31	-13.57	-32.29	-40.43	-8.44	-22.10	-38.38	-20.71	-29.19	-32.61
0.0387	-	-36.25	-42.35	-3.35	-0.87	-2.08	2.73	-5.33	-7.45	-12.37	-13.18	-33.83	-14.05	-30.61	-38.96	-8.09	-21.46	-37.27	-20.29	-28.38	-31.64
0.0473	-	-34.83	-41.00	-3.58	-1.79	-1.70	1.02	-5.52	-6.97	-12.54	-13.92	-32.32	-14.62	-29.00	-37.42	-7.75	-20.86	-36.08	-19.89	-27.53	-30.64
0.0560	-	-33.43	-39.62	-3.71	-2.69	-1.16	-0.55	-5.67	-6.62	-12.69	-14.69	-30.83	-15.24	-27.48	-35.87	-7.45	-20.32	-34.83	-19.53	-26.68	-29.67
0.0647	-	-32.06	-38.25	-3.78	-3.49	-0.53	-1.90	-5.80	-6.38	-12.80	-15.40	-29.41	-15.84	-26.07	-34.36	-7.22	-19.84	-33.60	-19.21	-25.87	-28.74
0.0733	-	-30.76	-36.93	-3.82	-4.14	0.13	-2.98	-5.88	-6.24	-12.89	-16.02	-28.09	-16.36	-24.80	-32.92	-7.06	-19.44	-32.40	-18.94	-25.12	-27.89
0.0820	-	-29.56	-35.72	-3.86	-4.66	0.78	-3.81	-5.95	-6.15	-12.95	-16.52	-26.89	-16.79	-23.68	-31.61	-6.98	-19.12	-31.28	-18.73	-24.44	-27.13
0.0907	-	-28.48	-34.62	-3.91	-5.05	1.38	-4.42	-5.99	-6.11	-12.99	-16.91	-25.83	-17.12	-22.72	-30.42	-6.96	-18.86	-30.27	-18.56	-23.86	-26.46
0.0993	-	-27.53	-33.65	-3.98	-5.33	1.90	-4.87	-6.02	-6.08	-13.02	-17.21	-24.91	-17.37	-21.90	-29.37	-6.99	-18.65	-29.37	-18.43	-23.36	-25.90
0.1080	-	-26.70	-32.81	-4.07	-5.53	2.33	-5.20	-6.03	-6.07	-13.03	-17.43	-24.13	-17.56	-21.22	-28.47	-7.06	-18.50	-28.59	-18.33	-22.95	-25.43

Table 13. Risk Premiums for Purchase of Variety V6 by Location, by ARAC

ARAC	Prot Only	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18	L19	L20
-0.1000	-	-35.08	-42.22	9.66	9.51	9.63	9.78	9.36	4.18	2.12	-15.30	-32.00	-10.02	-27.18	-37.83	-2.50	-16.97	-37.22	-15.58	-26.80	-29.86
-0.0913	-	-35.19	-42.12	9.74	9.59	9.71	9.90	9.38	4.73	2.09	-15.12	-32.24	-9.83	-27.77	-38.02	-2.36	-16.97	-37.13	-15.51	-26.76	-29.84
-0.0827	-	-35.25	-41.92	9.91	9.77	9.89	10.11	9.46	5.32	2.13	-14.83	-32.40	-9.54	-28.37	-38.12	-2.11	-16.87	-36.93	-15.34	-26.61	-29.71
-0.0740	-	-35.21	-41.57	10.16	10.04	10.16	10.43	9.61	5.96	2.25	-14.38	-32.46	-9.11	-28.96	-38.09	-1.74	-16.65	-36.59	-15.04	-26.32	-29.42
-0.0653	-	-35.04	-41.04	10.50	10.42	10.53	10.85	9.84	6.63	2.43	-13.74	-32.36	-8.53	-29.50	-37.89	-1.22	-16.25	-36.06	-14.60	-25.83	-28.94
-0.0567	-	-34.69	-40.28	10.92	10.89	11.01	11.37	10.11	7.31	2.68	-12.87	-32.07	-7.77	-29.94	-37.47	-0.51	-15.66	-35.31	-13.98	-25.12	-28.24
-0.0480	-	-34.13	-39.27	11.41	11.44	11.58	11.98	10.42	7.97	2.98	-11.75	-31.56	-6.84	-30.23	-36.82	0.39	-14.85	-34.32	-13.17	-24.17	-27.28
-0.0393	-	-33.37	-38.03	11.94	12.04	12.24	12.64	10.72	8.57	3.28	-10.41	-30.86	-5.76	-30.34	-35.94	1.48	-13.83	-33.08	-12.19	-23.01	-26.09
-0.0307	-	-32.42	-36.62	12.48	12.62	12.93	13.31	10.96	9.03	3.55	-8.91	-30.05	-4.61	-30.27	-34.94	2.73	-12.68	-31.68	-11.10	-21.69	-24.75
-0.0220	-	-31.40	-35.18	12.98	13.10	13.60	13.88	11.07	9.29	3.71	-7.40	-29.26	-3.51	-30.03	-33.96	4.02	-11.53	-30.25	-10.03	-20.36	-23.38
-0.0133	-	-30.44	-33.89	13.33	13.35	14.12	14.22	10.98	9.29	3.69	-6.09	-28.62	-2.64	-29.66	-33.17	5.19	-10.54	-28.96	-9.13	-19.20	-22.18
-0.0047	-	-29.68	-32.92	13.44	13.25	14.37	14.20	10.62	8.99	3.40	-5.18	-28.21	-2.17	-29.20	-32.69	6.04	-9.88	-27.99	-8.54	-18.34	-21.30
0.0040	-	-29.17	-32.34	13.17	12.71	14.23	13.68	9.93	8.38	2.76	-4.83	-27.98	-2.20	-28.68	-32.49	6.44	-9.63	-27.42	-8.35	-17.88	-20.83
0.0127	-	-28.89	-32.10	12.42	11.65	13.66	12.59	8.88	7.43	1.75	-5.09	-27.83	-2.79	-28.08	-32.43	6.31	-9.80	-27.21	-8.56	-17.80	-20.75
0.0213	-	-28.75	-32.10	11.18	10.05	12.66	10.90	7.44	6.16	0.35	-5.94	-27.64	-3.92	-27.39	-32.34	5.67	-10.33	-27.26	-9.14	-18.03	-20.99
0.0300	-	-28.65	-32.20	9.47	7.99	11.38	8.69	5.67	4.60	-1.39	-7.28	-27.33	-5.53	-26.60	-32.12	4.57	-11.13	-27.44	-10.02	-18.47	-21.44
0.0387	-	-28.49	-32.29	7.47	5.63	9.97	6.15	3.71	2.87	-3.33	-8.93	-26.89	-7.45	-25.75	-31.73	3.14	-12.12	-27.63	-11.12	-19.05	-21.99
0.0473	-	-28.23	-32.29	5.38	3.23	8.64	3.59	1.75	1.13	-5.28	-10.69	-26.34	-9.48	-24.86	-31.17	1.55	-13.19	-27.75	-12.31	-19.66	-22.55
0.0560	-	-27.85	-32.17	3.42	1.04	7.52	1.27	-0.05	-0.48	-7.06	-12.35	-25.73	-11.40	-23.97	-30.49	-0.03	-14.21	-27.76	-13.49	-20.22	-23.05
0.0647	-	-27.37	-31.93	1.72	-0.80	6.64	-0.65	-1.56	-1.85	-8.57	-13.77	-25.08	-13.05	-23.11	-29.74	-1.49	-15.12	-27.64	-14.54	-20.68	-23.43
0.0733	-	-26.84	-31.60	0.33	-2.24	6.01	-2.15	-2.76	-2.94	-9.76	-14.92	-24.45	-14.38	-22.33	-28.97	-2.75	-15.87	-27.42	-15.42	-21.03	-23.70
0.0820	-	-26.28	-31.22	-0.79	-3.32	5.56	-3.27	-3.66	-3.78	-10.67	-15.79	-23.85	-15.40	-21.63	-28.23	-3.79	-16.45	-27.13	-16.11	-21.26	-23.85
0.0907	-	-25.74	-30.84	-1.66	-4.10	5.25	-4.08	-4.33	-4.41	-11.33	-16.43	-23.30	-16.15	-21.03	-27.55	-4.63	-16.89	-26.81	-16.64	-21.41	-23.93
0.0993	-	-25.24	-30.47	-2.34	-4.67	5.03	-4.65	-4.82	-4.86	-11.82	-16.90	-22.82	-16.69	-20.52	-26.94	-5.30	-17.21	-26.50	-17.02	-21.49	-23.95
0.1080	-	-24.79	-30.15	-2.88	-5.06	4.86	-5.06	-5.16	-5.19	-12.16	-17.23	-22.40	-17.08	-20.11	-26.41	-5.84	-17.44	-26.20	-17.31	-21.52	-23.93

Table 14. Risk Premiums for Purchase of Variety V7 by Location, by ARAC

ARAC	Prot Only	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18	L19	L20
-0.1000	-	-51.87	-58.63	-6.10	-2.67	-8.59	-0.26	-9.02	-24.40	-16.16	-24.05	-53.04	-22.28	-50.99	-58.92	-21.50	-37.04	-52.04	-32.90	-43.20	-48.90
-0.0913	-	-52.54	-59.05	-6.13	-2.54	-8.78	0.04	-9.31	-24.88	-16.46	-24.08	-52.75	-22.21	-50.91	-58.60	-21.35	-36.89	-52.19	-32.58	-42.84	-48.89
-0.0827	-	-53.18	-59.42	-6.19	-2.41	-8.99	0.38	-9.64	-25.34	-16.81	-24.01	-52.46	-22.08	-50.83	-58.27	-21.21	-36.74	-52.26	-32.26	-42.43	-48.85
-0.0740	-	-53.77	-59.72	-6.29	-2.29	-9.22	0.74	-10.03	-25.73	-17.22	-23.81	-52.15	-21.88	-50.74	-57.91	-21.09	-36.61	-52.25	-31.94	-41.98	-48.79
-0.0653	-	-54.26	-59.91	-6.43	-2.20	-9.46	1.13	-10.46	-25.98	-17.68	-23.47	-51.82	-21.62	-50.59	-57.53	-20.96	-36.47	-52.15	-31.62	-41.49	-48.67
-0.0567	-	-54.58	-59.95	-6.60	-2.15	-9.69	1.54	-10.91	-26.00	-18.17	-22.98	-51.44	-21.31	-50.35	-57.08	-20.81	-36.29	-51.93	-31.29	-40.96	-48.48
-0.0480	-	-54.63	-59.78	-6.77	-2.18	-9.87	1.95	-11.33	-25.67	-18.62	-22.35	-50.95	-20.95	-49.91	-56.52	-20.56	-36.03	-51.56	-30.92	-40.38	-48.15
-0.0393	-	-54.30	-59.32	-6.91	-2.30	-9.94	2.32	-11.64	-24.91	-18.95	-21.60	-50.28	-20.56	-49.16	-55.78	-20.15	-35.58	-51.02	-30.45	-39.73	-47.59
-0.0307	-	-53.48	-58.49	-6.94	-2.53	-9.83	2.59	-11.73	-23.67	-19.06	-20.77	-49.32	-20.17	-47.97	-54.75	-19.51	-34.86	-50.26	-29.81	-38.96	-46.74
-0.0220	-	-52.12	-57.26	-6.81	-2.85	-9.51	2.71	-11.54	-21.99	-18.85	-19.94	-47.99	-19.79	-46.31	-53.38	-18.59	-33.81	-49.25	-28.97	-38.06	-45.53
-0.0133	-	-50.32	-55.69	-6.54	-3.21	-8.98	2.63	-11.08	-19.99	-18.35	-19.19	-46.28	-19.44	-44.24	-51.66	-17.45	-32.45	-48.01	-27.94	-37.02	-44.01
-0.0047	-	-48.23	-53.89	-6.19	-3.52	-8.32	2.37	-10.42	-17.87	-17.64	-18.56	-44.32	-19.09	-41.92	-49.70	-16.19	-30.89	-46.61	-26.78	-35.86	-42.28
0.0040	-	-46.06	-51.99	-5.86	-3.75	-7.61	1.98	-9.67	-15.80	-16.84	-18.07	-42.23	-18.73	-39.54	-47.63	-14.90	-29.25	-45.12	-25.60	-34.63	-40.47
0.0127	-	-43.90	-50.09	-5.57	-3.89	-6.86	1.52	-8.93	-13.89	-16.06	-17.67	-40.14	-18.36	-37.21	-45.55	-13.67	-27.65	-43.59	-24.46	-33.39	-38.68
0.0213	-	-41.83	-48.21	-5.33	-4.00	-6.09	1.02	-8.25	-12.18	-15.34	-17.36	-38.10	-17.99	-34.99	-43.51	-12.50	-26.13	-42.05	-23.40	-32.16	-36.94
0.0300	-	-39.85	-46.36	-5.10	-4.11	-5.27	0.44	-7.65	-10.70	-14.71	-17.13	-36.13	-17.68	-32.89	-41.53	-11.40	-24.73	-40.51	-22.43	-30.95	-35.29
0.0387	-	-37.95	-44.55	-4.87	-4.27	-4.38	-0.24	-7.16	-9.44	-14.19	-17.00	-34.27	-17.46	-30.92	-39.62	-10.40	-23.46	-38.98	-21.57	-29.78	-33.73
0.0473	-	-36.15	-42.78	-4.63	-4.47	-3.44	-1.02	-6.77	-8.43	-13.79	-16.96	-32.50	-17.34	-29.09	-37.78	-9.51	-22.35	-37.46	-20.83	-28.65	-32.28
0.0560	-	-34.45	-41.08	-4.41	-4.71	-2.46	-1.84	-6.49	-7.65	-13.51	-17.02	-30.86	-17.31	-27.43	-36.03	-8.76	-21.40	-35.97	-20.20	-27.59	-30.94
0.0647	-	-32.86	-39.46	-4.23	-4.95	-1.50	-2.65	-6.30	-7.08	-13.31	-17.14	-29.35	-17.36	-25.93	-34.40	-8.17	-20.61	-34.55	-19.68	-26.61	-29.73
0.0733	-	-31.40	-37.96	-4.09	-5.18	-0.58	-3.39	-6.19	-6.69	-13.19	-17.29	-27.98	-17.44	-24.61	-32.90	-7.73	-19.98	-33.21	-19.27	-25.72	-28.66
0.0820	-	-30.08	-36.59	-4.01	-5.38	0.26	-4.02	-6.12	-6.43	-13.12	-17.43	-26.77	-17.54	-23.48	-31.55	-7.45	-19.49	-31.98	-18.95	-24.94	-27.73
0.0907	-	-28.90	-35.36	-3.99	-5.54	0.99	-4.52	-6.08	-6.28	-13.08	-17.57	-25.71	-17.64	-22.52	-30.34	-7.28	-19.11	-30.86	-18.71	-24.26	-26.93
0.0993	-	-27.88	-34.28	-4.02	-5.67	1.61	-4.91	-6.06	-6.18	-13.06	-17.68	-24.80	-17.73	-21.72	-29.29	-7.21	-18.83	-29.88	-18.53	-23.68	-26.27
0.1080	-	-26.99	-33.35	-4.09	-5.76	2.12	-5.21	-6.06	-6.13	-13.06	-17.77	-24.03	-17.80	-21.06	-28.39	-7.21	-18.62	-29.02	-18.40	-23.21	-25.72

Table 15. Risk Premiums for Purchase of Variety V8 by Location, by ARAC

ARAC	Prot Only	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18	L19	L20
-0.1000	-	-39.00	-46.13	3.46	1.42	1.23	1.52	1.08	-15.77	-6.01	-19.69	-35.92	-15.92	-31.19	-41.85	-8.14	-21.16	-40.57	-19.39	-29.44	-33.76
-0.0913	-	-39.49	-46.41	3.93	1.67	1.45	1.79	1.25	-16.55	-5.85	-19.78	-36.50	-15.78	-32.14	-42.40	-8.12	-21.49	-40.67	-19.36	-29.39	-34.11
-0.0827	-	-39.98	-46.65	4.42	1.93	1.68	2.08	1.41	-17.31	-5.71	-19.81	-37.07	-15.62	-33.17	-42.92	-8.06	-21.79	-40.67	-19.24	-29.20	-34.42
-0.0740	-	-40.43	-46.82	4.94	2.19	1.92	2.38	1.56	-17.99	-5.58	-19.78	-37.58	-15.42	-34.25	-43.36	-7.97	-22.04	-40.54	-19.00	-28.84	-34.66
-0.0653	-	-40.82	-46.89	5.48	2.44	2.16	2.69	1.67	-18.51	-5.49	-19.65	-38.00	-15.18	-35.32	-43.68	-7.84	-22.21	-40.23	-18.62	-28.28	-34.79
-0.0567	-	-41.10	-46.82	6.03	2.66	2.39	2.98	1.73	-18.80	-5.46	-19.43	-38.28	-14.91	-36.32	-43.84	-7.65	-22.29	-39.71	-18.06	-27.51	-34.79
-0.0480	-	-41.24	-46.60	6.55	2.82	2.59	3.23	1.71	-18.77	-5.52	-19.10	-38.39	-14.62	-37.14	-43.80	-7.39	-22.25	-38.95	-17.34	-26.52	-34.63
-0.0393	-	-41.17	-46.21	7.04	2.91	2.75	3.42	1.58	-18.35	-5.68	-18.67	-38.29	-14.31	-37.65	-43.54	-7.05	-22.09	-37.97	-16.44	-25.36	-34.31
-0.0307	-	-40.86	-45.64	7.48	2.88	2.85	3.50	1.33	-17.53	-5.94	-18.15	-37.96	-14.01	-37.72	-43.06	-6.63	-21.78	-36.82	-15.43	-24.09	-33.82
-0.0220	-	-40.29	-44.93	7.82	2.73	2.89	3.46	0.99	-16.37	-6.28	-17.58	-37.43	-13.72	-37.30	-42.41	-6.15	-21.35	-35.59	-14.38	-22.85	-33.18
-0.0133	-	-39.50	-44.11	8.03	2.47	2.85	3.29	0.61	-14.96	-6.64	-17.01	-36.71	-13.48	-36.40	-41.65	-5.63	-20.82	-34.43	-13.44	-21.78	-32.44
-0.0047	-	-38.54	-43.24	8.04	2.12	2.76	3.00	0.25	-13.44	-6.96	-16.49	-35.85	-13.30	-35.15	-40.82	-5.15	-20.23	-33.46	-12.72	-21.00	-31.64
0.0040	-	-37.48	-42.36	7.80	1.70	2.64	2.63	-0.05	-11.95	-7.22	-16.06	-34.89	-13.20	-33.70	-39.95	-4.72	-19.62	-32.72	-12.30	-20.55	-30.83
0.0127	-	-36.36	-41.45	7.27	1.23	2.52	2.18	-0.32	-10.55	-7.45	-15.73	-33.86	-13.19	-32.17	-39.01	-4.37	-19.02	-32.20	-12.19	-20.40	-30.04
0.0213	-	-35.20	-40.52	6.47	0.69	2.45	1.62	-0.60	-9.29	-7.70	-15.52	-32.75	-13.28	-30.63	-37.98	-4.09	-18.47	-31.80	-12.36	-20.49	-29.27
0.0300	-	-34.01	-39.55	5.42	0.06	2.46	0.93	-0.95	-8.20	-8.01	-15.44	-31.59	-13.50	-29.12	-36.85	-3.89	-17.99	-31.44	-12.77	-20.74	-28.53
0.0387	-	-32.80	-38.52	4.21	-0.66	2.56	0.11	-1.39	-7.31	-8.44	-15.49	-30.39	-13.84	-27.67	-35.63	-3.80	-17.63	-31.06	-13.36	-21.07	-27.84
0.0473	-	-31.60	-37.46	2.94	-1.45	2.74	-0.80	-1.94	-6.62	-8.97	-15.66	-29.19	-14.30	-26.29	-34.36	-3.83	-17.39	-30.62	-14.06	-21.39	-27.20
0.0560	-	-30.43	-36.38	1.70	-2.25	2.98	-1.74	-2.56	-6.15	-9.58	-15.93	-28.02	-14.84	-25.03	-33.08	-3.99	-17.28	-30.10	-14.79	-21.66	-26.63
0.0647	-	-29.31	-35.31	0.57	-3.00	3.25	-2.62	-3.19	-5.86	-10.20	-16.25	-26.91	-15.40	-23.90	-31.83	-4.27	-17.28	-29.52	-15.47	-21.84	-26.12
0.0733	-	-28.28	-34.29	-0.42	-3.67	3.52	-3.40	-3.78	-5.71	-10.78	-16.57	-25.90	-15.92	-22.91	-30.66	-4.63	-17.34	-28.92	-16.06	-21.94	-25.67
0.0820	-	-27.35	-33.35	-1.26	-4.23	3.76	-4.04	-4.29	-5.67	-11.29	-16.87	-24.99	-16.39	-22.06	-29.58	-5.03	-17.43	-28.31	-16.55	-21.97	-25.29
0.0907	-	-26.54	-32.52	-1.95	-4.68	3.96	-4.55	-4.71	-5.68	-11.71	-17.13	-24.20	-16.77	-21.34	-28.63	-5.43	-17.53	-27.74	-16.93	-21.94	-24.96
0.0993	-	-25.83	-31.79	-2.52	-5.02	4.11	-4.94	-5.04	-5.73	-12.04	-17.34	-23.52	-17.08	-20.76	-27.80	-5.82	-17.63	-27.23	-17.22	-21.89	-24.68
0.1080	-	-25.23	-31.18	-2.99	-5.29	4.20	-5.23	-5.30	-5.78	-12.30	-17.51	-22.94	-17.32	-20.28	-27.09	-6.17	-17.71	-26.77	-17.43	-21.82	-24.46

For the other varieties, less locations have positive risk premiums (Tables 8-15). For example, variety V1 has positive premiums only for location L6 (0.25 c/bu). Variety V2 has positive premiums for slightly risk preferring to risk averse buyers for location L6 and for risk averse buyers from locations L3 to L8. Variety V3 has positive risk premiums for location L5 for risk averse buyers and L6 for risk neutral buyers. Variety V8 has positive risk premiums for several locations for risk preferring to slightly risk averse buyers (locations L3, L4, L6, and L7) and for L5 across all risk attitudes.

Functional and Wheat Characteristics

The model analyzed the effect of specifying functional requirements as a purchasing strategy. Tests were conducted at costs of $40/sample for a farinograph test and $30/sample for a loaf volume test. All tests are 95% accurate, and 5 samples for every 10 grain cars were tested. The farinograph and loaf volume tests were incorporated using a hypogeometric function at a 95% accuracy level to derive individual and joint probabilities. If the characteristic is not met with the test, it is rejected. Two models were analyzed. The first included tests for absorption, peaktime, and stability using a farinograph test. The second included testing for absorption, peaktime, stability and loaf volume. All probabilities are based on wheat and functional characteristic requirements. Average procurement costs delivered to the PNW are also derived.

The joint probability of meeting requirements is .75 when the farinograph test is conducted (Table 6). Probabilities of meeting absorption, peaktime, and stability requirements all increased to .95 and procurement cost increased by 2 c/bu. The results indicate that testing for loaf volume, although it does not have as much impact on the results as the farinograph test, improves the likelihood of conforming to end-user requirements. The largest increase in conformance for a characteristic comes from inclusion of loaf volume which results in an increase from .88 to .95. This also resulted in an increase in the joint probability of meeting all requirements from .75 to .81. Average cost increased 1 c/bu. The probability of meeting requirements increases considerably when functional characteristic tests are performed with minimal cost compared to the base case.

Stochastic dominance for functional tests indicated dominance over protein only and varied by ARAC (Figures 3 to 4). For the functional tests, farinograph was the most preferred, while absorption was the second preferred set and stability and loaf volume was the third and fourth preferred sets depending on risk attitude. Risk premiums relative to protein only increased as buyers shifted from risk averse to risk preferring. Risk premiums for absorption and farinograph tests increase as risk attitude became less risk averse and peaked when buyers were risk neutral and then declined for buyers who were more risk preferring. Risk premiums by ARAC ranged from 8.9 to 19.4 c/bu for farinograph, 2.4 to 11.6 c/bu for absorption, -0.2 to 3.1 c/bu for stability, and -0.5 to 4.4 c/bu for loaf volume. When compared to variety strategies, farinograph tests dominated all of the individual variety strategies, while absorption dominated all but V6 for less risk averse and risk preferring buyers and V2 and for moderate to highly risk averse buyers (Figure 3). Comparing stochastic dominance of functional tests to location

strategies indicated farinograph tests dominated all purchase by location strategies, while absorption dominated all but L5 for highly risk averse buyers. Thus, purchase strategies using functional tests for farinograph and absorption largely dominated purchase by variety or location strategies. However, the degree of preference relative to protein only strategy (measured by the risk premium) was highly dependent on risk aversion of decision maker and for the best of the alternative strategies (farinograph) only 19.4 to 8.9 c/bu.

Summary

Consistency for functional characteristics in wheat is a major problem faced in the relationship between suppliers and end-users. Variability in quality for functional characteristics has implications for food processors including the risk of not conforming to requirements, greater costs associated with higher quality purchasing and increased operating costs associated with likely stock-out costs due to non-conformance. A common procurement strategy designed to alleviate this problem is to purchase based on wheat protein levels. Less common alternative strategies include vertical integration, targeting of origins, and pre-shipment samples. End-users use these procurement strategies as a means to improve quality in their final product. However, changes in varieties planted along with variable growing conditions have led to increased conformance uncertainties.

Procurement strategies were modeled using stochastic simulation to estimate procurement costs and risks. Procurement strategies included purchase by variety, location, and strategies with tests for functional characteristics. Procurement costs delivered to PNW and Minneapolis markets and the probability of meeting buyer requirements were estimated. The models utilized estimated functional relationships and correlations between wheat characteristics and functional characteristics to determine probabilities of meeting buyer requirements. Testing costs for varieties and functional characteristics were included in sensitivities involving these requirements.

The probability of meeting functional targets increases as purchase strategies increase in specificity from purchase by protein to incorporation of functional characteristics (Table 5). Costs increase as well. The base case involves procuring HRS based solely on protein levels; whereas, the variety model bases its purchases on specific varieties. End-users face the choice of either a higher probability of conformance through variety purchases with higher costs, or a lower probability of conformance through protein purchases with lower costs. Functional testing yields the highest joint probability of conformance but at a higher cost. The purchase by location and purchase by variety models are less costly than the high protein strategies and yield similar results, providing evidence that these strategies are optimal. However, the highly specific strategy of purchasing specific varieties in specific locations did not result in risk premiums that were higher than functional trait buying strategies. Further, the locations where individual varieties yielded positive risk premiums over a protein only strategy were highly limited both in the case of varieties and locations.

The results quantified costs and risks of these alternative procurement strategies in the case of HRS shipments to the U.S. west coast. The results indicate that there is substantial risk of not meeting functional trait requirements using conventional contracts. These risks can be mitigated by specifying either targeted variety, locations, or both, though at higher costs. Use of functional trait specifications in contracts, even at higher costs, is a much more cost-effective means of reducing these risks.

Risk premiums indicated the amount of premium that end-users could be prepared to pay for specifications beyond traditional grain factors. These results suggested risk premiums in the area of -1.8 to7.6 c/b for purchases from prescribed L3 to L8, -3.6 to 13.1 c/bu for particular varieties including V6 and V2 (V6 preferred for less risk averse and risk preferring buyers and V2 for moderate to highly risk averse buyers), and 8.9 to 19.4 c/bu for farinograph and 2.4 to 11.6 c/bu for absorption.

HRS suppliers and end-users can utilize contract requirements to improve quality. The wheat protein model, which is used extensively by end-users, involves modest cost increases, (protein premiums), and protein levels are easy to measure. More specific strategies, such as location and/or variety, involve greater communication between producers and end-users. Long term relationships could likely develop to facilitate such a contract.

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Appendix A

Estimated Functional Relationships

Appendix Table 1. Functional Relationships for Protein Only Procurement Strategy

	Absorption	Extraction	Peak Time	Stability	Loaf Volume	Ash	Flour Protein
Intercept	34.27	59.34	14.66	102.15	5.55	.1929	5.24
Wheat Protein	.9297	-.2983			.6160	.0104	.5970
Moisture	-.44058					.0095	-.0888
Falling Number		-.0074		.0327	.0074		
Test Weight	.26978	.2329		-1.6398			
1000 Kernel Weight	.14312	.1223	-.1870		-.1840		
R2	.31	.1168	.0403	.2022	.0997	.0723	.5518
RMSE	1.5691	2.0169	2.0927	5.6397	2.7192	.0418	.4879

Appendix Table 2. Functional Relationships for Absorption

	Protein Only	Variety	Location	Location by Variety	Stability	Loaf Volume
Intercept	34.27	23.73	36.54	29.16	53.88	34.27
Wheat Protein	.9297	0.9543	0.8646	.8598	.8431	.9297
Moisture	-.44058	-.2786	-0.4560	-.3492	-.5519	-.44058
Falling Number						
Test Weight	.26978	.4310	.2515	.4209		.26978
1000 Kernel Weight	.14312	0.0905	.1381		0.1606	.14312
V2				-1.2247		
V3		-1.2014		-1.0986		
V5		-0.9653				
V6		2.2896		2.0432		
V7		-.6760		-.6694		
V8				1.6744		
L4			1.1833	1.0215		
L6				2.2443		
L10			1.7474	1.8587		
L12			1.1772	1.0147		
L19			-1.6799			
Abs						
Peak Time						
Stability					-0.0722	
Loaf Volume						
R2	.31	.46	.36	.49	.33	.31
RMSE	1.5691	1.3919	1.5108	1.3702	1.5492	1.5691

Appendix Table 3. Functional Relationships for Peak Time

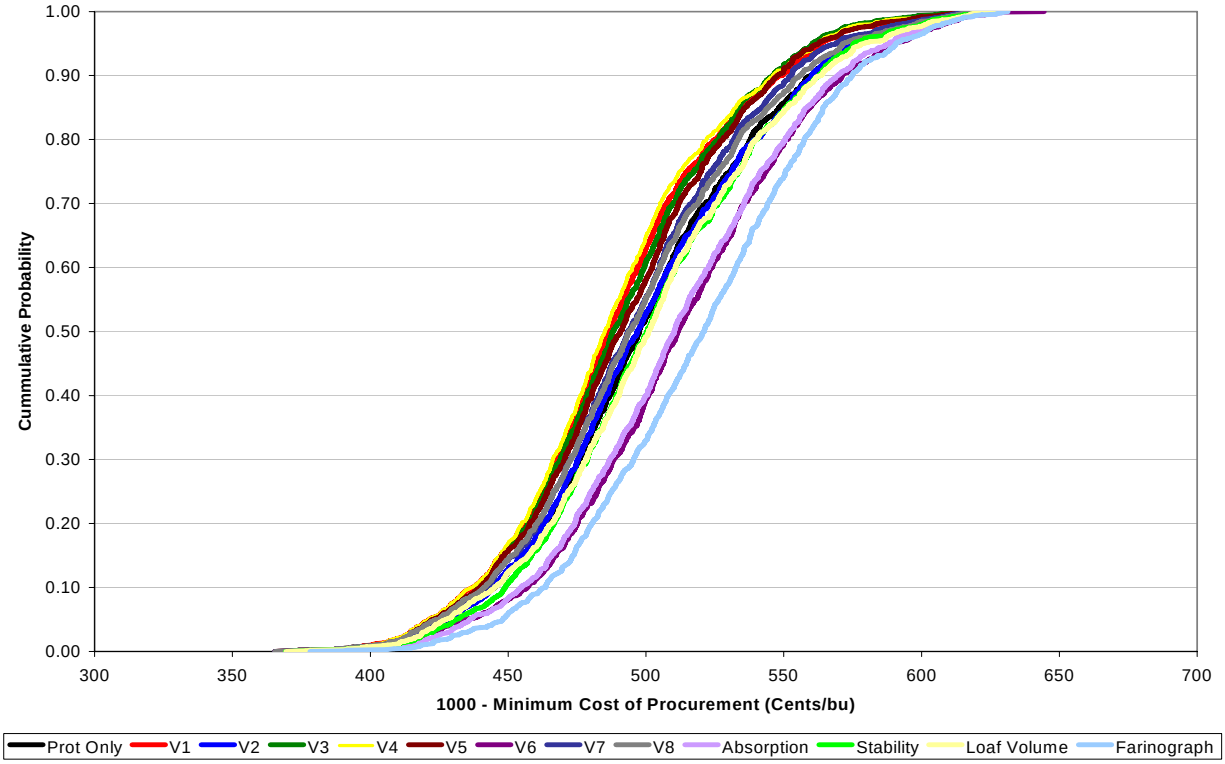
	Protein Only	Variety	Location	Location by Variety	Absorption	Stability	Loaf Volume
Intercept	14.66	7.02	14.87	6.00	31.90	-.2.47	14.66
Wheat Protein							
Moisture		.2851		.5669	-.3488		
Falling Number		.0066				-.0048	
Test Weight						.2500	
1000 Kernel Weight	-.1870	-.1457	-.1930	-.1334	-.1570	-.1692	-.1870
V1		-1.0581		-.9472			
V2		4.8999		4.3596			
V4		-1.2538		-1.1546			
L1				-.8301			
L3				1.0289			
L5			2.6920	2.7499			
L13			-1.2626	-1.0700			
L15				1.1224			
Abs					-.2204		
Peak Time							
Stability						.2038	
Loaf Volume							
R2	.04	.24	.09	.27	.07	.33	.04
RMSE	2.0927	1.8742	2.0352	1.8211	2.0565	1.7663	2.0927

Appendix Table 4. Functional Relationships for Stability

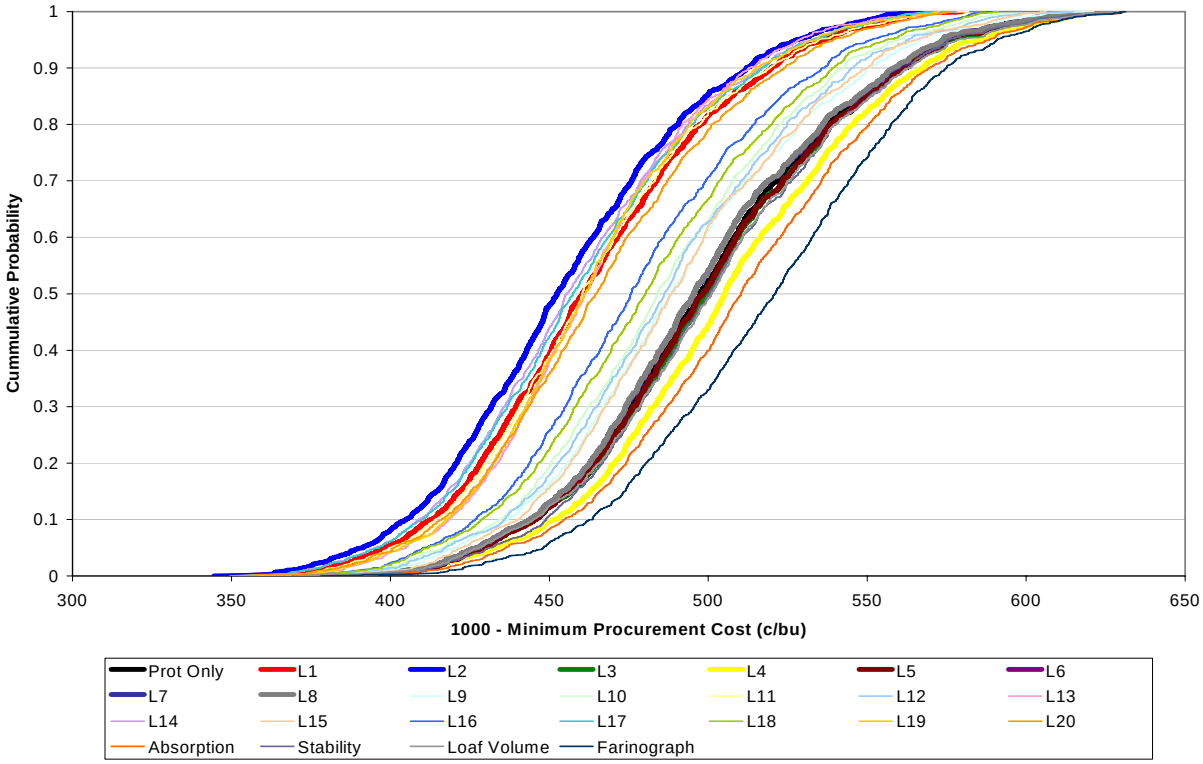
	Protein Only	Variety	Location	Location by Variety	Absorption	Loaf Volume
Intercept	102.15	94.48	115.21	107.51	163.68	96.07
Wheat Protein						
Moisture					-1.2070	
Falling Number	.0327	.0371	0.0258	0.0287	0.0311	.0289
Test Weight	-1.6398	-1.5429	-1.7909	-1.6909	-1.4186	-1.5920
1000 Kernel Weight						
V1		-2.6162				
V2		4.7278		4.0272		
V3		3.5272		4.1484		
V4		-4.3342		-3.2344		
V7		2.3422		2.2731		
L11			-3.8430	-3.0163		
L13			-5.0321	-3.9431		
L14			-2.6645	-2.4948		
Abs					-.9426	
Peak Time						
Stability						
Loaf Volume						.3999
R2	.20	.29	.26	.32	.27	.23
RMSE	5.6397	5.3058	5.4296	5.2190	5.3993	5.5677

Appendix Table 5. Functional Relationships for Loaf Volume

	Protein Only	Variety	Location	Location by Variety	Absorption	Stability	Farinograph
Intercept	5.55	6.61	8.80	8.07	5.55	9.11	-1.28
Wheat Protein	.6160	.6775	.5748	.5068	.6160	.5223	
Moisture							
Falling Number	.0074				.0074		
Test Weight							
1000 Kernel Weight	-.1840	-.1649	-.1743	-.1346	-.1840	-.2006	-.2711
V5		2.0953		1.7830			
V6		5.3597		5.4382			
V7		1.3864					
V8		1.1730					
L3			1.7403	1.5071			
L4			1.4024				
L8				-2.7555			
L13			-1.4430				
L17				1.3291			
L18			1.6795	1.9110			
L19			2.5367	2.8387			
Abs							.3129
Peak Time							
Stability						.0886	.1098
Loaf Volume							
R2	.10	.29	.16	.33	.10	.11	.13
RMSE	2.7192	2.4089	2.6187	2.3277	2.7192	2.6389	2.5961



Appendix Figure 1. Distributions for Inverted Cost of Procurement for Purchase by Protein, Variety, and Functional Trait



Appendix Figure 2. Distributions for Inverted Cost of Procurement for Purchase by Protein Only, Location, and Functional Trait