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Valuation of New Spring Wheat Varieties: Tradeoffs for Growers and End-users

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Highlights

Variety release decisions involve tradeoffs between grower and end-user characteristics as well as significant uncertainties about agronomic, quality, and economic variables. In this paper, methodologies were developed to value tradeoffs for grower and end-user characteristics for wheat that capture effects of variability in agronomic, quality, and economic variables. The models developed were applied for three experimental varieties of Hard Red Spring (HRS) wheat which have since been released and for two hypothetical varieties. Results indicate two of the experimental varieties provide improvements in grower and end-use value over most of the incumbents. Comparison of a risk adjusted portfolio model consisting of characteristics of end-use and grower values with stochastic dominance techniques (tested for level of significance) indicate similar results.

Introduction

During the past decade there has been heightened interest in grain quality among domestic processors and producers of hard wheat. A contributing factor has been the increasingly important role of grain quality in international competition. Concern has come to be focused on two fundamental issues, quality consistency and end-use performance. These issues have important implications for many functions of the grain marketing systems including plant breeding strategies and variety release decisions.

There are fundamental tradeoffs in variety development decisions. These typically involve yields, disease resistance, and quality. Gains in one characteristic often involve losses in others. Growers want greater yields and disease resistence, without foregoing returns due to quality shortfalls. End-users have demands for functional characteristics that are typically proxied by measurable wheat quality characteristics (e.g., protein). Finally, changes in the regulation and release of new cultivars with specific characteristics not contained in grades would influence the choice of wheat by end-users. Ultimately, decision makers must confront these tradeoffs in making breeding and variety release decisions.

The purpose of this summary is to illustrate results of a methodology that determines the *ex ante* value of new varieties to end-users and growers. The analytical model is applied to both experimental and hypothetical varieties and comparisons are made relative to a set of incumbent varieties. Extensive agronomic and quality panel data were used to derive distributions and correlations among characteristics and varieties. These agronomic and quality relationships are combined with distributions of economic variables to estimate distributions of the value of varieties for end-users and growers. The results were evaluated using a portfolio analysis to determine the extent that the value of one variety is superior to others. The results illustrate tradeoffs in the value of a variety for end-users and growers.

Model Development

The value of a new variety is typically different for growers and end-users. Growers may be indifferent between the choice of planting existing varieties and a new variety that has similar

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agronomic characteristics (yields, disease resistance, etc.), but higher end-use characteristics (higher gluten strength, absorption, flour extraction, etc.). In contrast, end-users may find no value in improved agronomic characteristics (additional yield, straw strength, etc.) while growers may perceive these as substantial. Since the development, release, and adoption of a new variety relies on its value to both growers and end-users, three models were developed. The first estimates the value of a new variety to end-users; the second estimates the value of a new variety to growers. Results from the first two models are compared and contrasted to evaluate tradeoffs. The third model developed is a combination (portfolio) of the first two models and incorporates correlations between end-user and grower values. This is utilized to illustrate tradeoffs and rank variety preferences.

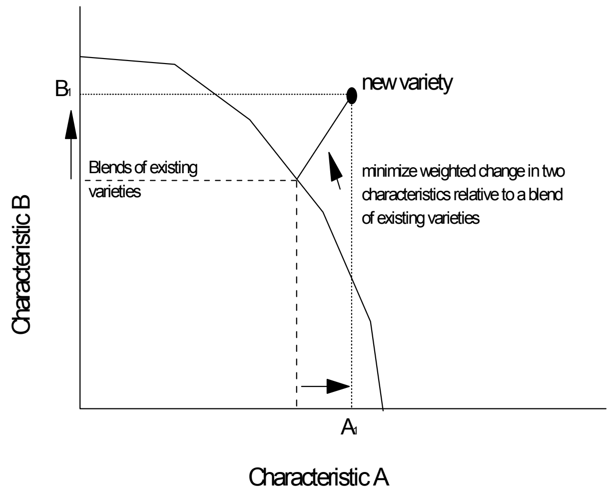

Figure 1. Comparison of Value of New Variety with Frontier Derived from Blends of Existing Varieties.

End-user Value Model

A theoretical model was developed to estimate the value of a new variety with specific end-use characteristics. An end-user evaluating a new variety can compare its value to that of incumbent varieties or to values obtained from blending existing varieties. Consider an example in which there are two end-use characteristics of interest to buyers. A range of varieties are available, each with end-use characteristics. Varieties can also be blended to meet the needs of buyers. Blending opportunities expand the range of alternatives available to buyers. Graphically, a 'frontier' exists as in Figure 1. A new variety with levels of end-use characteristics A_1 and B_1 lies outside the frontier of existing varieties. The extent of improvement in each characteristic is gauged by comparison with a particular point on the frontier, representing a blend of existing varieties.

Grower Value Model

Values of individual varieties to growers were derived by estimating the certainty equivalent of utility of income for each variety using stochastic simulation.

Income was defined as:

$$I = [P - T - H + P^P*(C) - D^P*(C) - D^T*TW - D^{FN}*FN - D^{Vom}*VS] * Y$$

where I is Income in dollars per acre, P^w is base price Mpls. (random), T is transportation cost from ND to Mpls., H is local handling, P^P is premium for protein >14% (random), D^P is discount for protein <14% (random), C is Protein content (correlated with yield), D^T is test weight discount (random), TW is max(58-Test weight,0) amount test weight is below 58 lbs/bu, D^{FN} is falling number discount (random), FN is binary indicating falling number is lower than limit (300 minutes), D^{Vom} is vomitoxin discount (random), VS is binary indicating vomitoxin exceeds critical limit (2ppm), and Y is yield (includes variability due to disease, etc.).

Agronomic and Quality Data

Data for each of the models were obtained from a number of sources. Variety yields, protein content, and other wheat, flour, and end-use characteristics are from results of North Dakota variety trials (Department of Cereal Science and Food Technology). Means, standard deviations, and correlations were estimated by variety for the years 1989-1997. For the end-user model, values for wheat and end-use characteristics were estimated for two groups of varieties.

Prices, Premiums, and Discounts

Farm prices and protein premiums are average marketing year values, with distributions estimated from daily observations from 1989-1997

(Minneapolis Grain Exchange). Farm prices were estimated as Minneapolis cash prices less transportation costs and local elevator handling charges. Premiums and discounts for the farmer value model were assumed to be random and drawn from distributions (Table 1). Protein premiums and discounts reflect average protein premiums/discounts from 14% for Minneapolis cash HRS wheat from 1989-1997. Values of discounts for test weight, falling numbers, and vomitoxin were taken from results of a 2001 survey of North Dakota and Montana elevator managers' premiums/discounts for HRS wheat (Wilson and Dahl). Survey results revealed average discounts of 4 cents/bu for test weight of 57 lbs/bu, 26 cents/bu for sprout damage, and 20 cents/bu for vomitoxin. Discounts for sprout damage were applied for falling numbers less than 300 minutes.

The marginal value of flour extraction was estimated using Drynan's valuation model utilized by Dahl and Wilson. This model estimates the value of wheat to millers (milling margin) after adjusting for differences in quality characteristics (moisture, foreign material, dockage, and extraction rates). The effect of a higher flour extraction rate from this model was a 5 cents/bu increase in value for a one percentage point increase in flour extraction. This was used in the end-user model.

The marginal value of absorption was estimated assuming that additional absorption values would reduce the amount of flour required to produce a given volume of dough. Using this assumption and a traditional bread formulation, increasing absorption by 1% (62% to 63% absorption) reduces both flour and wheat needs by .5%. If wheat costs $4.00/bu, then the marginal value of additional absorption is approximately 5 cents/bu which was the value utilized in the end-user model.

An initial value for the constant relative risk aversion parameter of .5 was assumed following Petersen and Fraser. Then a range of constant relative risk aversion parameters around this initial value was examined.

Table 1. Distributions for Prices, Premiums, and Discounts for Farmer Value Model (cents/bu).

	Mean	Std	Correlation	Distribution
MGE Futures Price	436	77		Normal
Protein 15%	40	34	.85 with protein 13%	Normal Truncated at 0
Protein 13%	-14	19	.85 with protein 15%	Normal Truncated at 0
Test Weight	-4	5		Normal Truncated at 0
Falling Number	-26	37		Normal Truncated at 0
Vomitoxin	-20	44		Normal Truncated at 0

Source: Distributions for prices estimated from Minneapolis Grain Exchange; premiums and discounts for test weight, falling number, and vomitoxin are from Wilson and Dahl.

Vomitoxin

To capture the affect of vomitoxin, VS (a binary variable representing presence/ absence of vomitoxin in levels exceeding tolerance) was estimated from a two-stage procedure. First, a distribution was estimated for head score values (HS). Head scores are a visual scale used for approximating yield loss due to vomitoxin in field plots developed by Stack and McMullen and represents the percent of yield loss at a location. Johnson et al. and Nganje et al. developed a similar historical measure by crop reporting district (CRD) for North Dakota from 1993-2000 for wheat and barley. These values represent the average wheat loss due to fusarium head blight (FHB) from the hypothetical yield without FHB. This was utilized to derive an average yield loss for locations and using data from 1989 to 2000. Observations were assigned to represent experiment stations based on the CRD in which they lie geographically. Those for years 1989 to 1992 were assigned zero values representing no or minimal vomitoxin levels. Then a relationship was estimated between experimental head score values, variety resistance ranking, and vomitoxin [deoxynivalenol (DON)] levels using data from Stack. These two relationships were used to simulate DON levels to determine whether the discounts should be applied for a given variety and year.

Results: End-use and Grower Models

Base case results were developed for three North Dakota experimental varieties (ND 678 - Keene; ND 694 - Parshall; and ND 695 - Reeder) that were recently released and two hypothetical varieties. The two hypothetical varieties were constructed to extend the range of potential tradeoffs between value to growers and end-users. One of the hypothetical varieties has higher levels of characteristics for end-use with average yields, while the other is a high-yielding low end-use quality variety. Results were estimated for both the end-user and grower models. Sensitivities were then conducted to evaluate the effects of the risk aversion coefficient, improving wheat and end-use characteristics, protein premiums, alternative end-use value (protein and test weight only), and the effect of Loan Deficiency Payments (LDP).

End-user Model: Base Case

Base case models were developed for each of the varieties and compared to the best blend of incumbent varieties. The incumbent varieties were assumed to be the eight varieties grown throughout the time period 1989-1997. Other incumbent varieties (2398, Gunner, McNeal, Oxen and Russ) were treated as new varieties due to the limited number of observations from which distributions and correlations could be estimated. From the simulation, means and the distribution of end-use values for each of the varieties were summarized.

Means for end-use values estimated for the base case range from a high of .01 cent/bu for Gunner to a low of -85.4 cents/bu for the hypothetical high yielding variety. All varieties other than Gunner have negative means. This does not mean that end-use quality is less than for incumbent varieties because the new varieties are compared to the best blend of the incumbents within each simulated year, rather than a specific incumbent variety. This represents a valuation comparison where an end-user compares quality from a new variety to that which could be obtained by blending incumbent varieties.

Evaluation of the distributions for end-use valuations by variety indicate for the hypothetical high quality variety, 50% of observations would exceed the value of incumbents (Figure 2). In contrast, 45% of observations exceeded the value of the best incumbent for Gunner, 21% for ND 694, 7% for ND 695, and less than 5% for ND 678 and the hypothetical high yielding variety. Distributions for end-use values are not symmetric across the new varieties and there are distinct differences among the distributions. Both ND 695 and Oxen have a lower probability of having larger negative end-user values in comparison to McNeal; however, McNeal has a higher probability of having more positive end-user values than did either ND 695 or Oxen. It is notable that most of the newer varieties have at least a small probability of having end-use value greater than that of the base incumbent varieties.

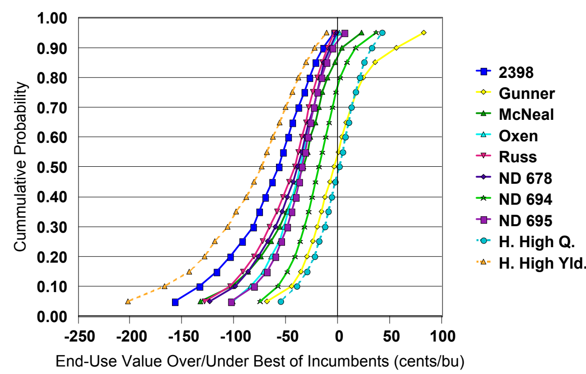

Figure 2. Distribution of End-use Value Over/Under Best of Incumbents for Newer/Hypothetical Varieties.

Comparisons were made to the best blend of incumbent varieties (2375, Amidon, Butte 86, Grandin, Gus, Len, Marshall, and Stoa) in deriving the end-use value of a variety. Though the model allowed blending of varieties; in almost all iterations, the test variety was compared to a single incumbent variety (i.e., a single incumbent variety was the best blend among alternatives). Since tested varieties have different levels of end-use characteristics, they are potentially positioned on different areas on the frontier of best quality available from existing varieties. Therefore, comparisons of the tested variety to the frontier would necessarily be to different groups of incumbent varieties depending on the end-use characteristics of the tested variety. Composition of the best incumbent varieties at the frontier for each variety tested indicates differences which reflect positioning along the frontier. For example, varieties considered higher end-use quality (Gunner, Gus, H. High Q., and ND 694) were most often compared within the simulation to Gus, Grandin, and Len. Those with lower end-use quality (H. High Yld, 2398, and 2375) were compared more frequently to Grandin, Butte 86, and 2375 than were the higher quality varieties. This suggests that these two groups of varieties are positioned on different areas of the frontier, indicating different characteristics or combinations of characteristics may be more important in determining how these groups of varieties relate to incumbents.

Grower Model: Base Case

Models were used to compare grower value to the incumbent varieties for each of the five new varieties. Using simulated values for average utility, certainty equivalents were derived for all incumbent and new varieties being evaluated (Table 2 and Figure 3).

Table 2. Estimated Certainty Equivalent Income, by Variety, Base Case.

New and Hypothetical Varieties		Incumbent Varieties	
	Certainty		Certainty
	Income/A		Income/A
ND 678	184	2375	183
ND 694	202	2398	169
ND 695	213	Amidon	173
H. High Qual.	191	Butte 86	173
H. High Yld.	209	Grandin	178
		Gunner	214
		Gus	180
		McNeal	189
		Oxen	187
		Russ	178
		Stoa	170

Estimated certainty equivalent incomes ranged from $169-$190/A. Results for many of the incumbent varieties indicate lower certainty equivalent incomes than for the experimental varieties. Of the incumbent varieties, 2398 had the lowest certainty equivalent of $169/A, while Gunner had the highest value to growers among all incumbents ($214/A). Of the new varieties, all but ND 678 had higher certainty equivalent incomes than the incumbent varieties except for Gunner. ND 678 had a higher grower value than all but Gunner, McNeal, and Oxen.

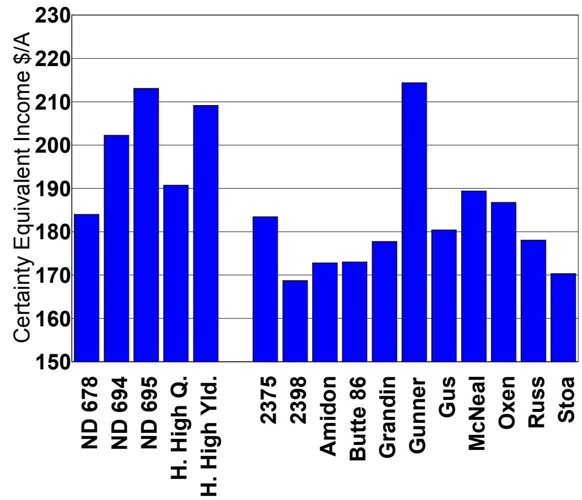

Figure 3. Certainty Equivalent Income/Acre, by Variety, Base Case.

The probability that the utility of income for new/hypothetical varieties exceeded that of incumbent varieties was derived through simulation (Figure 4). ND 695 was most likely to have higher utility of income than incumbent varieties. The probability that ND 695 had higher utility of income than incumbents was .21. This was followed by the hypothetical high quality (.186), the hypothetical high yielding (.178), ND 694 (.150), and ND 678 (.099) varieties. These probabilities indicate the proportion of simulated years where utility would be greater for the newer variety than that of any of the incumbent varieties. Since Gunner (an incumbent variety) has the greatest certainty equivalent income, it is expected that the proportion of time that new varieties exceed that of incumbents would be less.

Sensitivities

A constant relative risk aversion coefficient of .5 was assumed in the base case grower model. Since the value of relative risk aversion coefficients varies by grower, the grower valuations were examined over a range of relative risk aversions, ranging from .1 to .9.

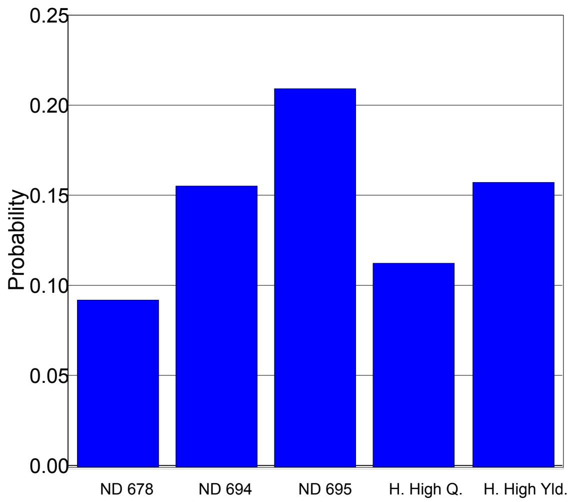

Figure 4. Probability That Utility of Income for New/Hypothetical Varieties Exceed that of Incumbent Varieties.

Certainty equivalent incomes suggest growers would respond differently depending on their risk aversion when evaluating new and incumbent varieties. Less risk averse growers (lower relative risk aversion coefficients) would prefer ND 678 over 2375, McNeal over the hypothetical high quality variety, and Amidon over Butte 86. More risk averse growers (higher relative risk aversion coefficients) would prefer 2375 over ND 678, the hypothetical high quality variety over McNeal, and Butte 86 over Amidon. Similarly, the more risk averse growers would view the difference between ND 695 and the hypothetical high yielding variety as smaller than would the less risk averse growers.

Comparison of Grower and End-use Values

Results from both grower and end-user models were combined to demonstrate potential tradeoffs among varieties. This provides insight into how new varieties are valued in relation to existing varieties. Two figures are presented. The first shows mean values for end-users against the certainty equivalent income of growers for each variety (Figure 5). The second, shows the range of end-use value (± 2 standard deviation units from mean) (Figure 6). This provides insight into the prospective range of end-use values and how they compare to incumbents.

Comparison of mean end-use values and grower certainty equivalent incomes indicates that many of the newer and hypothetical varieties provide greater grower income than incumbents (Figure 5). Most notable of these are ND 695, ND 694, Gunner, and the hypothetical high yield variety. All of these varieties have grower values that are $10-$25/A greater than other varieties. Similarly, Gunner, ND 694, and the hypothetical high quality variety dominate end-use value of incumbents (are rightward of incumbents). Other comparisons can also be deduced from these relationships. For example, ND 694 is worth 20 cents/bu more to end-users than is ND 695, but growers would prefer the latter because of its $10/A higher certainty equivalent income.

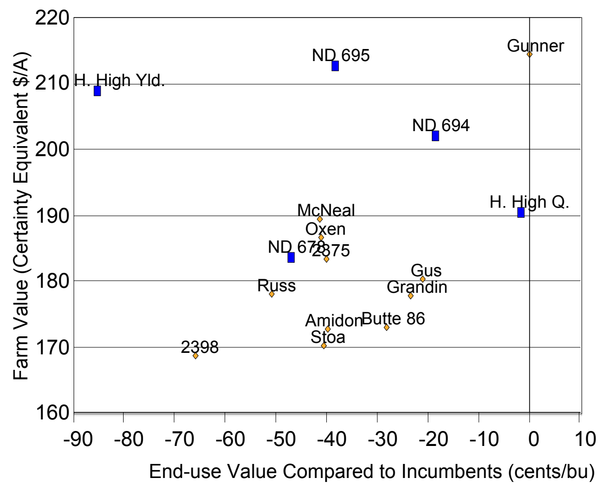

Figure 5. Relationship of Grower Value to Mean End-user Value.

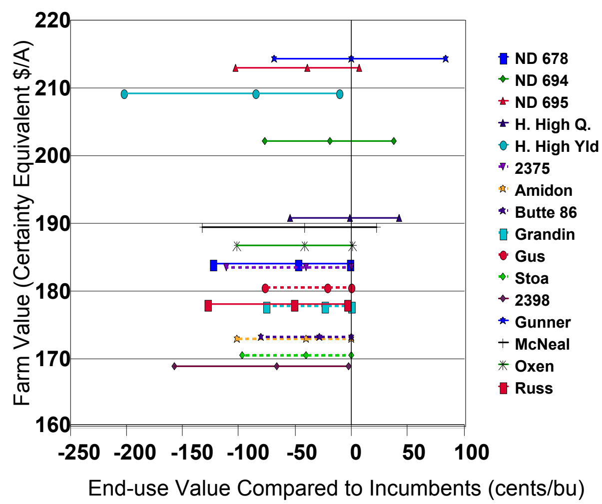

Figure 6. Relationship of Grower Value to Range (+-2 Standard Deviation Units) of End-use Values.

Comparison of grower values to the prospective range of end-use values reveals additional information. The varieties Gunner, ND 694, and the hypothetical high quality variety would provide end-use value greater than that of the best of the base incumbent varieties a high proportion of the time (Figure 6). ND 695, McNeal, and Oxen also are able to exceed quality of the best of the incumbent varieties, but for a lesser proportion of the time. All of these varieties reflect a technical improvement in end-use quality.

Sensitivity of Valuation for Individual Characteristics

Sensitivity analysis was used to evaluate how levels of characteristics affect the value of a new variety. This was done by examining values for a new variety which was similar to ND 694 except for a higher level of a specific characteristic. This was replicated for several individual characteristics utilizing one percent changes in characteristic levels. One exception to this was the head scab resistance rating for which a new variety was examined that was one rating category more resistant to head scab than ND 694.

Grower and end-user values were affected differently depending on the characteristic (Figure 7). For example, one percent changes in protein and yield had the largest impacts on grower value. A one percent higher wheat protein increased grower value by $2.92/A, while one percent higher yields increased grower value by $2.17/A. Yields had no affect on end-use value and the effect of protein on end-use value was less than that of either extraction or absorption. The effect of a one percent change in absorption had the highest effect on end-use value (+4 cents/bu), followed by flour extraction which increased grower value by 3 cents/bu. The effect of a one unit change in head scab rating increased grower value by 27 cents/A. This result should be interpreted with caution in that it represents value throughout the state. The value to growers in specific areas where vomitoxin is more likely to occur could be higher.

Alternate End-use Valuation

An alternative model was estimated where varieties were valued only on protein and test weight (marginal values for other characteristics set to zero value). These are the characteristics normally measured in the market and where premiums and discounts are explicitly applied. Results of this end-use model were compared to certainty equivalent incomes of the base case grower model. Comparison of the tradeoffs for the alternative end-use values with those in the base case indicate some differences. First, average end-use values for many of the varieties were higher (less negative) than in the base case. For example, ND 694 increased in value from -19 cents/bu to -15 cents/bu, and ND 695 increased from -39 cents/bu to -23 cents/bu. Gunner actually declined in end-use value, moving from a slightly positive to a slightly negative value. The hypothetical high quality variety also decreased significantly in value. It declined from having just a slightly negative value to an average mean value of near -20 cents/bu. This indicates that this potential variety is getting a significant portion of end-use value from higher extraction and absorption rates.

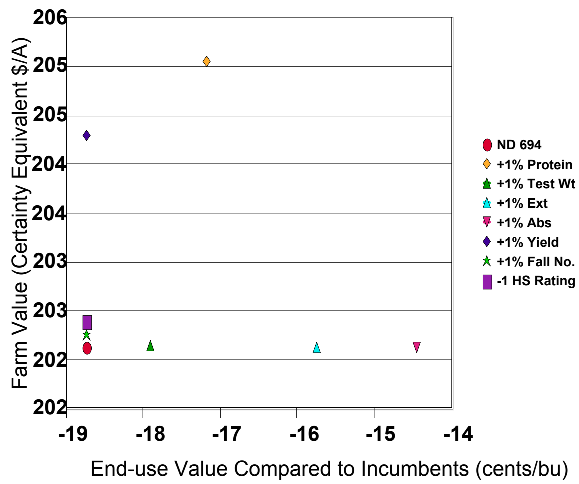

Figure 7. Sensitivity of Grower/End-use Value to Changes in Individual Wheat/Quality Characteristics.

Examination of changes in the range of end-use values are less dramatic, except for the two hypothetical varieties. Values for the higher quality variety had a smaller range and were more negative, on average, than in the base case. This suggests that this potential variety would have lower end-use value than if we consider contributions of extraction and absorption rates. In contrast, the higher yielding variety increased end-use value with a portion of the potential range of end-use values exceeding that of incumbents. This is dramatically higher than that in the base case where none of the range for the higher yielding variety exceeded the value of incumbents.

Under this alternative, the experimental varieties have a higher valuation than they did under the base case. This indicates that the experimental varieties are closer to the frontier than they are in the base case. These results differ from the base case in that they reflect currently applied market premiums and discounts. The base case also incorporates implicit premiums and discounts for higher/lower extraction and absorption rates which are not reflected in current industry practices. Thus, valuing varieties only on protein and test weight results in greater value than if the marginal implicit values of more measurable end-use characteristics were included.

Effect of Protein Premiums

The effect of changes in the distribution of protein premiums was also examined. Mean protein premiums and discounts in the base case were doubled (i.e., premiums for protein > 14% were raised to 80 cents/bu/percentage point while discounts for protein less than 14% were increased to 28 cents/bu/percentage point). The variability of protein premiums was reduced (i.e., premiums and discounts were assumed fixed at mean values).

Doubling protein premiums increased the grower value of higher protein varieties more than that for lower protein varieties. Gunner, the highest protein variety, increased in grower value from $214/A to $230/A, an increase of $15/A. In contrast, the variety 2398 increased in grower value by only $1/A and the hypothetical high yielding variety actually declined in grower value.

Reducing the variability of protein premiums increased grower values of all varieties. Increased grower values ranged from a low of $0.30/A for Oxen to a high of $2.36/A for the hypothetical high yielding variety. Of the varieties that increased in value the most, some were lower protein varieties (hypothetical high yielding variety and 2398) while others like McNeal had a larger standard deviation for wheat protein. This suggests that reducing variability of protein premiums increased grower values of varieties with lower and more variable wheat protein relative to those with more stable, moderate to higher levels of protein.

Effect of LDPs

During the 1980s, the development and adoption of varieties that were higher yielding, but of lower quality were reinforced by the mechanics of the deficiency payment program. Under previous legislation deficiency payments were based on proven yields, and payments were in the range of 15 to 198 cents/bu. Though deficiency payments as they were defined in the 1980s have been discontinued, a surrogate program emerged in the 1996 farm bill called the Loan Deficiency Program (LDP) or marketing loan. The effect of LDP's on grower value were examined by modifying the base case grower model to include payments for LDPs. This was accomplished by adding revenue of 30 cents/bu[1] when the base wheat price was in the lowest 1/3 of the price distribution. This was utilized to reflect the historical occurrence of LDP payments.[2]

Grower values for each of the varieties examined increased on average $4 - $6/A. Butte 86 was affected least by the addition of the LDP program (value increased $4.39/A), while the hypothetical high yielding variety increased in value $6.32/A. The difference in value over the base case for these two varieties is $1.93/A. Therefore, the addition of the LDP program has the affect of widening the advantage of higher yielding varieties over varieties with higher end-use quality. The increase in advantage of higher yielding varieties over lower yielding high quality varieties due to the LDP program was less than $2.00/A.

The sensitivity analysis provides perspective on effects of specific factors on value. However, to select varieties based on sensitivity analysis requires estimation of all sensitivity factors which may be unrealistic to simulate by breeders. Alternative risk based methods would be preferred for ranking varieties.

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[1] A rate of 30 cents/bu for LDPs was utilized and is similar to the rate applied by Westcott and Price when examining the effect of LDP provisions.

[2] LDP payments for wheat occurred in 1998, 1999, and 2000. The potential for LDP payments was assumed to be three years out of nine.

Comparison of Variety as Portfolio of Characteristics of Grower and End-user Values

The joint value of varieties to end-users and growers was evaluated simultaneously using a portfolio approach (McCarl, Knight, Wilson, and Hastie). This approach considers goals of growers and end-users simultaneously and accounts for covariance. A portfolio was developed combining characteristics of end-use and grower values. The portfolio value of a variety was estimated as the weighted sum of end-use and grower values. An initial weight of .5 was assumed for each implying equal weighting of grower and end-user values for the portfolio value of a variety. These portfolio values were simulated using stochastic simulation and means and variances for each variety portfolio were collected.

Values of portfolios were then compared to determine preferences for varieties. For this, a variety (A) was considered to be preferred over an alternative variety (B) if the risk adjusted portfolio value of variety A was greater than that for variety B. Sensitivities were conducted to examine the effect of alternative weights for end-use and grower value and risk attitude parameters on preferences for varieties.

Mean portfolio values and variances were collected from the simulations for each of the varieties. These were used to estimate the risk adjusted portfolio value for each variety. These risk adjusted portfolio values were utilized to compare and rank varieties. Risk adjusted values ranged from a high of 3 cents/bu for Gunner to a low of -52 cents/bu for the hypothetical high yielding variety. Higher risk adjusted portfolio values indicate that a variety is preferred to another variety with lower values. Gunner would be preferred to all other varieties tested. Butte 86 would be preferred over Stoa, but not over either ND 695 or Grandin.

Since the initial assumption on weights was arbitrary, sensitivities were conducted for alternative weights for end-use and grower values. End-use weights were varied from 0 to1 and grower weights were simply 1 minus end-use weight. A weight of 0 for end-use value represents the special case where value is only based on grower values, and a weight of 1 represents only end-use values. Results indicate that as weights change, the ordering of preference for varieties changes (Figure 8). For example, when end-use weights are less than .5, the hypothetical high yielding variety increases in rank. As end-use weights approach 0, this variety is one of the more preferred varieties. With lower end-use weights, ND 695 is preferred over Butte 86, Grandin, and Gus. As end-use weights increase, Gus, Grandin, and Butte 86 become preferred over ND 695.

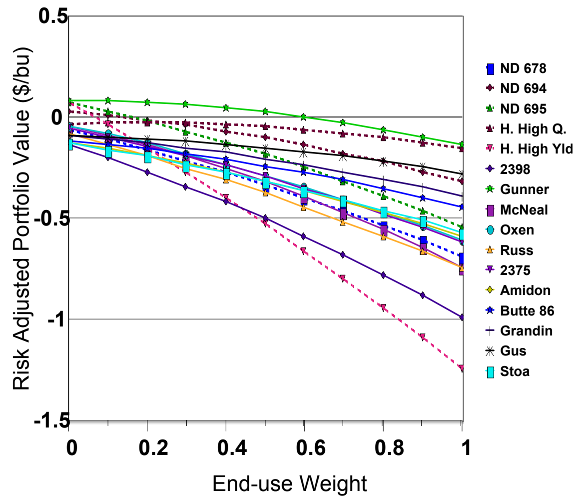

Figure 8. Sensitivity of Risk Adjusted Portfolio Value to End-use Weights, by Variety.

Changes in θ, the risk aversion parameter, affect the estimated value of the risk adjusted portfolio for individual varieties, but had little impact on rankings of varieties. As θ increased (become more risk averse), risk adjusted portfolio values for varieties decreased. However, the varieties that did change rankings included ND 678, McNeal and Stoa, where McNeal was preferred to Stoa and ND 678 for lower values for θ and Stoa and ND 678 were preferred to McNeal for higher values for θ.

Summary and Conclusions

A methodology to value tradeoffs for growers and end-users when evaluating new varieties of hard wheat was developed. Models were developed to place a value on new varieties for growers and end-users and to make comparisons of tradeoffs. These models were applied for three experimental varieties (ND 678 - Keene, ND 694 - Parshall, and ND 695

Reeder) which have since been released, and for two hypothetical varieties (hypothetical high quality and high yield) which were added to supplement the range of potential grower/end-user value comparisons.

Some important findings were:

- Grower and end-user values exhibited tradeoffs across varieties.

- Grower values for experimental varieties were higher than for incumbent varieties. End-use value of experimental varieties varied.

- Grower's risk preferences affected values for a few varieties. Less risk averse growers would prefer ND 678 over 2375 and Amidon over Butte 86, while more risk averse growers' preferences were reversed.

- The sensitivity of grower and end-user values were affected differently by changes in variety characteristics. Grower values increased most for a one percent change in protein ($2.92/A) and yields ($2.17/A). End-use values increased most for a one percent change in absorption (+ 4 cents/bu) and flour extraction rates (+3 cents/bu).

- Doubling the value of protein premiums (from 40 cents/bu for each percent over 14 percent protein and doubling discounts from an average of 14 cents/bu for each percent under 14 percent protein) was to increase grower value of higher protein varieties by as much as $10-$15/A. The effect on lower protein varieties was less and, in fact, the hypothetical high yield variety actually declined in grower value.

- Reducing variability in protein premiums was to increase the grower value for varieties with lower and more variable wheat protein relative to varieties with moderate to higher levels that were more stable.

- The LDP program had the effect of increasing grower value of high yielding, low quality varieties relative to high quality, lower yielding varieties by less than $2/A. This was opposite the effect of higher protein premiums.

- Risk adjusted portfolio values for varieties comprised of characteristics of value to both end-users and growers suggest rankings of varieties in order of preference. Initial results indicate a ranking order (best to worst) of Gunner, hypothetical high quality, ND 694 (Parshall), Gus, ND 695 (Reeder), Grandin, Butte 86, Oxen, 2375, Stoa, Amidon, McNeal, ND 678 (Keene), Russ, 2398, and hypothetical high yield. These rankings varied by the weight applied to characteristics of grower and end-user value in the portfolio and, to a lesser extent, the risk aversion parameter.

Need for Further Study

There are five areas that are particularly important for future study and/or extensions of this research. One would be detailed analysis of the geographic scope of variety development decisions. It is important that in the United States varieties are developed to perform well in specific geographic regions. This has important implications for end-use consistency and productivity. Further analysis of the value of variety releases should consider adaptation for specific regions when determining farmer and end-use values. This is especially important in the case of vomitoxin where infestation levels have been affected both by location (environment) and cultivar, but is also important in that specific varieties are better adapted to specific locations.

A second area would be the strategic practicality of breeding for specific market needs or requirements (i.e., niches). Brennan suggested that in many cases this may not be practical due to the transitory nature of niches and the time lag in breeding decisions. Yet with market maturity there seems to be more interest in breeding to meet niche market requirements. As examples, General Mills recently has found extensive efficiency gains in processing by using some specifically bred varieties for manufacture of breakfast cereals; and there have been gains in breeding for the specific needs of the frozen dough and tortilla industries.

A third area of importance would be how FHB is incorporated in the analysis. This was incorporated in this study using available data. However, the analysis could be enhanced substantially by accounting for more geographic specificity in the incidence and likelihood of vomitoxin.

Fourth, an important area for consideration in the case of HRS wheat would be to explore the strategic implications of developing a strain of varieties that are distinctly higher yielding, perhaps with some other type of measurable characteristic to allow it to be distinguished in the market place. Results from this analysis suggest that the yield-quality frontier from incumbent varieties was particularly constricted and only very marginal improvements could be assessed.

Finally, an important aspect of variety valuation that should be considered is the diversity of quality desired by end-users. Not all end-users desire the highest quality (highest protein, test weight, etc.) for their products, nor the specific requirements used in this study. Therefore, not all end-users may value a specific new release similarly. For example, McNeal is a variety with very high mix tolerance (stability), a characteristic desired by some end-users of HRS wheats. McNeal has a higher mix tolerance than Gunner, the highest valued end-use variety from our base case. This suggests that end-use values where mix tolerance is an important attribute might value McNeal over Gunner. However, inclusion of mix tolerance as an element of end-use value is complicated by the fact that a specific valuation of an additional unit of mix tolerance is highly elusive.

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