WHEAT SEGREGATION AND IDENTITY-PRESERVATION COST

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Abstract

Budgets were used to estimate additional identity-preserved wheat production costs that ranged from $0.81 to $5.35 per bushel. A survey was developed to estimate the feasibility for country elevators to market identity-preserved wheat and the premiums required to do so; estimated premiums reported ranged from $0.05 to $1.45 per bushel.

Key Words: Identity-Preservation, Genetically Modified Wheat, Wheat Marketing

Introduction

Genetic modification uses recombinant DNA technologies to alter an organism's traits in a way that is not possible with traditional breeding methods (Fernandez-Cornego and McBride). There are currently no varieties of GM wheat being commercially produced or marketed in the U.S.; however, Monsanto Life Sciences has announced that they will be introducing a GM herbicide-tolerant spring wheat variety, possibly as early as the 2005 growing season.

GM crops have experienced little opposition in the U.S. from food processors, livestock feeders, or consumers. Some foreign buyers and consumers of U.S. crops have expressed concern about the safety of GM varieties and the products derived from them. In the European Union, lawmakers have imposed a four-year ban on approving new GM crops and are considering legislation that would require labeling for food products with greater than 0.9% GM material (Miller). Other countries that are currently pursuing GM labeling policies include Japan, Australia and New Zealand (Caswell). The percentage of total wheat produced in the US and exported to foreign markets, was 46.6% in 2000, 49% in 2001, and 60% in 2002 (USDA-ERS; NASS). As international markets like the European Union (EU) and Japan adopt labeling procedures for GM commodities and products made from them, a marketing system that segregates GM from non-GM crops will become important for producers interested in exporting to these countries (Golan, Kuchler, and Mitchell).

Because the U.S. wheat industry depends on several foreign markets, and because companies like Monsanto have been pursuing GM wheat varieties with enhanced quality traits, there will likely be a need to change current segregation procedures and implement a more precise identity-preserved system. According to Wilson *et al.,* there are at least 35 countries that currently have or are developing labeling laws for GM products. Kuntz identifies ten "at risk" countries currently importing Canadian Western Red Spring (CWRS) wheat varieties that would potentially divert all shipments from Canada, if a GM wheat variety currently being developed for CWRS were released.

Producers and grain handlers will have to make changes in the way they produce, transport, store, test, and sell wheat if segregation and identity-preservation are required either by market concerns about GM products or to capture the value of new traits. Both producers and grain handlers will want to consider the cost of various alternative segregation systems in making their decisions about how to manage GM wheat varieties.

Research Objectives

The general objective of this study is to determine the cost of implementing a segregated, identity-preserved marketing system for non-genetically modified wheat varieties in Oklahoma by 1) identifying steps that would be necessary to develop and monitor potential identity-preserved marketing systems for non-genetically modified wheat varieties in Oklahoma for the producer and the country elevator, and 2) estimating additional costs of potential identity-preservation systems for producers and country elevators marketing identity-preserved, non-genetically modified wheat.

Evaluating Producer Costs Using Enterprise Budget Software

In order to evaluate the costs of producing an identity-preserved, non-GM wheat (in our study not containing RoundUp Ready© wheat technology), we developed four budgets using Oklahoma State University Enterprise Budget Software developed by Doye *et al.* for different areas of Oklahoma including 1) a base case where budgets reflect a current wheat producer growing non-Roundup Ready© wheat that is not identity-preserved, 2) a budget where a non-Roundup Ready©, identity-preserved wheat is being produced, 3) a budget for acres taken out of wheat production on the farm producing an identity-preserved wheat due to isolation requirements, and 4) a budget where Roundup Ready© wheat is being produced.

To build general budgets, the total number of farm acres, wheat acres, and farms per county were found from the Agricultural Statistics Service for 28 counties in Oklahoma, using these estimates the average farm size and average number of wheat acres per farm were calculated for each county and averages for each of the regions were generated. This resulted in a farm size estimate of 743 acres in the northwest region with 244 acres of wheat, 1,812 acres in the panhandle region with 303 acres of wheat, and 602 acres in the southwest region with 233 acres of wheat. With IP wheat production, an isolation barrier is usually required to prevent any cross-contamination. We developed budgets for two different isolation barrier requirements: a 100-foot barrier suggested by Gustafson and a 300-foot barrier suggested by the Oklahoma Crop Improvement Association. The acres contained in the isolation area cannot be planted to another variety of wheat, rye, or triticale. In the identity-preserved wheat budgets, we assumed all wheat acres on a farm would be planted to IP wheat minus the respective isolation barriers. We also assumed that the wheat acres were consolidated in one tract. The number of isolation acres and IP wheat acres were calculated using equations 1 and 2.

(1) $$A_{IP} = \frac{\left[\left(\sqrt{A_W * 43{,}560}\right) - 2 * B\right]^2}{43{,}560}$$

(2) $$A_{Iso} = A_w - A_{IP}$$

where

A_W = Average number of current wheat acres per farm in each area (acres)

A_{IP} = Number of acres planted to identity preserved wheat (acres)

A_{Iso} = Number of isolation acres (acres)

$B =$ Barrier requirement; 100 ft or 300 ft (feet)

These calculations resulted in 214.77 (29.23) acres, 270.22 (32.78) acres, and 205 (28) acres for IP wheat (isolation barriers) in the northwest, panhandle, and southwest regions, respectively under the 100 ft isolation barrier assumption. With the 300ft barrier assumption, IP wheat (isolation barrier) acres were 162.27 (81.73) acres, 210.89 (92.11) acres, and 153.79 (79.21) acres for the northwest, panhandle, and southwest region, respectively. Because few farmers grow wheat in the northeast Oklahoma region the equations returned an unrealistically small field size. To correct for this, we assumed a wheat producer in northeast Oklahoma would have approximately 40 acres in wheat production currently with an average farm size of 329 acres, which was used to calculate IP wheat acres and isolation acres using equations 1 and 2. Calculations estimated 28.8 (11.2) acres and 11.9 (28.1) acres of IP wheat (isolation barriers) for the northeast region under the 100 ft barrier and 300 ft barrier assumptions, respectively.

A base case was made for each of the regions specified above. These budgets used the enterprise budget default values for wheat production in each area of Oklahoma. In addition, both wheat grain harvest and winter grazing were assumed to occur on all of the current average wheat acres per farm in each area.

When developing budgets for non-GM, IP wheat production, the average acres per farm estimates for that region were entered into the enterprise budget parameters as well as the average wheat acres per farm in that region minus acres taken out of wheat production due to isolation barriers (100 ft and 300 ft). In our analysis we assumed IP wheat producers would leave the isolation acres un-cropped and acres would remain in government base acres. Budgets were developed for these acres taken out of production. Seed prices were adjusted from $7 per bushel to $13.32 per bushel, the average cost of two new commercial varieties (Jagalene and

Cutter) marketed by AgriPro©. This assumes that the initial prices for non-GM, identity-preserved wheat seed will be similar to those of a new commercial wheat variety currently on the market.

An additional 16 hours of labor were included in the budget to clean out a combine before and after harvest, as well two additional hours to clean cultivation equipment before and after field work and four hours to clean planting equipment before and after planting, as suggested by Gustafson. The number of acres specified in the budget to which the combine would be used was set just above the break-even value for the number of acres needed to justify owning harvest equipment, assuming producer participation in custom harvest activities.

Additional on-farm storage needs were also included using OSU Extension Fact Sheet F0210, *Grain Storage Costs in Oklahoma* (Anderson and Noyes). Variable and fixed costs used in the analysis were \$0.176/bu/year and \$0.076/bu/year for a 3,000 bushel storage bin, \$0.16/bu/year and \$0.061/bu/year for a 5,000 bushel storage bin, \$0.143/bu/year and \$0.044/bu/year for a 10,000 bushel storage bin, and \$0.136/bu/year and \$0.039/bu/year for a 20,000 bushel storage bin, respectively. The optimal combination of 3,000-bushel, 5,000-bushel, 10,000-bushel, and 20,000-bushel bins for each isolation barrier assumption (100 ft and 300 ft) in each area was determined by using the combination that minimized excess capacity and the number of bushels to store per farm was determined by multiplying the number of IP acres by the average yield in each region. Once this combination was determined, equation 3 was used to calculate storage costs per acre of IP wheat produced.

$$(3) \qquad S_c = \frac{\left[\sum_{i=1}^{N-1} \left(SB_i * \left(FC_i + VC_i \right) \right) + \left(SB_N * FC_N + \left(SB_N - EC \right) * VC_N \right) \right]}{A_{IP}}$$

where

$SB_i =$ Storage capacity of filled storage bin (i) in bushels

$VC_i =$ Variable costs of filled storage bin (i) in $/bushel/year

$FC_i =$ Fixed costs of filled storage bin (i) in $/bushel/year

$SB_N =$ The storage capacity of the last storage bin (underutilized) used in bushels

$FC_N =$ Fixed costs of the last storage bin (underutilized) used in $/bushel/year

$VC_N =$ Variable costs of the last storage bin (underutilized) used in $/bushel/year

$EC =$ Excess capacity in the last on-farm storage bin (underutilized) used in bushels

$A_{IP} =$ Number of identity-preserved wheat acres

$S_c =$ On-farm storage costs used in the IP producer budgets ($/acre)

The cost of on-farm testing for IP, non-genetically modified wheat was included by using estimates from Wilson and Dahl of approximately $0.0015 per bushel, using ELISA strip tests. We include this cost in the budgets where on-farm storage is considered. In addition, field inspections may be required of the producer by the production contract. In the non-GM, IP wheat budgets, $2.75 per acre plus $15 per producer (assuming the IP producer is only growing one variety) was used to incorporate the cost of the certification process for those producers growing IP wheat; this estimate was obtained from the Oklahoma Crop Improvement Association.

We first calculated the returns over all specified costs per bushel for all identity-preserved, non- Roundup Ready© wheat produced on an average farm in each area. This value was calculated by using equation 4.

(4) $$\frac{\left(\left(R_{IP} * A_{IP}\right) + \left(R_{Iso} * A_{Iso}\right)\right)}{\left(A_{IP} * Y\right)} = IPR$$

where

R_{IP} = Returns over all specified costs per acre for producing identity-preserved, non-Roundup Ready© wheat on the identity-preserved wheat acres ($/acre)

R_{Iso} = Returns over all specified costs per acre for isolation acres taken out of production but remaining in government programs ($/acre)

A_{IP} = Number of acres planted to identity preserved wheat (acres)

A_{Iso} = Number of isolation acres (acres)

Y = Average wheat yield in each area (bushels/acre)

IPR = Total returns per bushel of identity-preserved, non- Roundup Ready© wheat sold ($/bushel)

In addition to the costs specified in the budgets for identity-preserved wheat production, Harbugh mentions that there is a 0.016 probability of on-farm commingling and Gustafson suggests that producers growing identity-preserved crops should discard the first 50 bushels of IP grain harvested and sell those bushels in the non-IP market. The procedure for including the probability of commingling and discarded grain is summarized in equation 5.

$$(5) \qquad MIN\left\{0, \left[\left(IPR - \left(\frac{R_c}{Y}\right)\right) * 1.016\right] * \left[\left(\frac{50}{(A_{IP} * Y)}\right) + 1\right]\right\} = C_{IP}$$

$$(6) \qquad MIN\left\{0, \left[\left(IPR - \left(\frac{R_r}{Y}\right)\right) * 1.016\right] * \left[\left(\frac{50}{(A_{IP} * Y)}\right) + 1\right]\right\} = C_{IP+r}$$

where

R_C = Current (base scenario) returns above all specified costs in each area ($/acre)

R_r = Returns above all specified costs in each area for producing Roundup Ready© wheat ($/acre)

Y = Average wheat yield in each area (bushels/acre)

A_{IP} = Number of acres planted to identity preserved wheat (acres)

$IPR =$ Total returns per bushel of identity-preserved, non- Roundup Ready© wheat sold ($/bushel)

$C_{IP} =$ Additional per bushel costs of producing an identity-preserved wheat considering both the probability of commingling and the cost of selling the first 50 bushels of IP wheat harvested in a non-IP market ($/bu)

$C_{IP+r} =$ Additional per bushel costs of producing an identity-preserved wheat considering the probability of commingling, cost of selling the first 50 bushels of IP wheat harvested, and the opportunity costs of not producing RR wheat ($/bu)

In order to estimate the cost of producing a non- Roundup Ready©, identity-preserved wheat crop including any opportunity costs for not producing Roundup Ready© wheat we developed budgets reflecting the potential returns or losses associated with Roundup Ready© wheat production in each of the areas.

We estimated potential herbicide cost reductions by using a Roundup Ready© wheat variety compared to using a current variety and herbicide control program in Oklahoma. A common weed control program in Oklahoma includes a 0.30 ounce per acre application of Finesse© herbicide with a 0.25 pound per acre application of 2-4D herbicide during early spring. (Peeper). Using herbicide prices from the enterprise budget software, this application would cost about $5.35 per acre. If applying a Roundup application of 1 pint per acre at $4.57 per pint, this would result in a $0.78 per acre herbicide cost reduction.

Because this is a new technology, perhaps the greatest uncertainty relates to the technology fee that will be charged. Other Roundup Ready© technology fees may provide some guidance as to the amount of the fee. If the fee charged is related to the value of the benefit conferred by the technology, then that relationship could be used to estimate the potential fee for the new wheat technology. Estimates for herbicide cost reduction when using Roundup Ready© soybeans vary depending on the area of the U.S. where they are being used, however, producers have reported reductions of herbicide anywhere from $17 to $37 per acre (Block; Brasher).

According to the American Soybean Association, soybean growers buying Roundup Ready© soybean seed are charged a \$10 to \$14 per acre technology fee. To find an estimate for a potential Roundup Ready© technology fee we used equation 7.

$$(7) \qquad \frac{TF_{SB}}{CR_{SB}} = \frac{TF_W}{CR_W}$$

where

TF_{SB} = Current estimates for Roundup Ready© soybean technology fees (\$/acre)

CR_{SB} = Current estimates of herbicide cost reductions when using Roundup Ready soybeans (\$/acre)

TF_W = Estimates for potential Roundup Ready© wheat technology fees (\$/acre)

CR_W = Estimates for potential herbicide cost reductions when using Roundup Ready wheat (\$/acre)

Using an estimated Roundup Ready© soybean technology fee of \$12 per acre, a herbicide cost reduction of \$29.50 per acre and the \$0.78 per acre estimated cost reduction from DeVuyst *et al.*, we calculated a potential technology fee for Roundup Ready© wheat varieties of \$0.317 per acre. It should be noted that only about 50% - 60% of all wheat acres in Oklahoma are treated with herbicide (Peeper).

Budgets were generated for each of the four areas specified above reflecting the potential net returns associated with production of Roundup Ready© wheat. Per acre seed costs were increased by the estimated \$0.317/acre technology fee. Yield estimates for each region were increased by 12.5% reflecting the potential increase in yield due to decreased weed pressure reported by Wilson *et al.*. Herbicide use was specified to be one application of Roundup© at a rate of 1 pint per acre at \$4.57 per pint including the cost of application. It was also assumed that wheat acres would be both harvested for grain and winter grazed. Once the per acre returns over all specified costs were determined for wheat producers in each area we substituted the return per acre into equation 5 and calculated the total cost of non- Roundup Ready©, identity-preserved wheat production, including the opportunity costs of not producing Roundup Ready© wheat. The equation for this calculation is equation 6 above.

Table 1 contains estimates of additional per-bushel costs for production of non-genetically modified (non- Roundup Ready©), identity-preserved wheat, the lowest cost estimate was $0.81 per bushel and the highest cost scenario was $4.91 per bushel. When opportunity costs for not growing Roundup Ready© wheat were included, the least cost scenario returned was $1.29 per bushel and the highest cost scenario was $5.35.

Country Elevator Segregation and Identity-Preservation Phone Survey

A questionnaire regarding current facilities and potential strategies for segregating and identity-preserving wheat was developed and sent to Oklahoma grain managers across Oklahoma. Questions regarding the number of truck weighing scales; the type of testing equipment; the number of dumping pits, elevating legs and elevator facilities; and the number of grains currently being handled at the location were included in the survey to determine their influence on the premiums required by country elevators. We also asked if the location surveyed was part of a multi-location firm, and if so, how many locations the firm had and if their IP strategy would be to segregate IP and non-IP wheat within each location of the firm or to devote one location to IP wheat. General requirements for marketing IP wheat were listed and questions regarding required premiums and barriers to IP implementation followed. Questions pertaining to elevator manager education and experience were also included.

A stratified sample of grain elevators in terms of size, location, and company structure (cooperative or private) was selected to request survey participation. We disseminated 44 questionnaires to country elevators in three different size categories; 18, 15, and 11 questionnaires were sent to small, medium, and large-sized country elevators, respectively. In terms of geographic distribution, 3, 22, 3 and 16 questionnaires were sent to Northeast Oklahoma, Northwest Oklahoma, the Oklahoma Panhandle, and Southwest Oklahoma, respectively. In addition, 26 of all of the country elevators that received questionnaires had a cooperative business structure, while 18 were privately operated. Follow-up phone calls were later made to the country elevators to collect manager responses.

Out of the 44 questionnaires distributed to Oklahoma country elevators, 39 phone surveys (88.6%) were successfully completed (14, 14, and 11 from small, medium, and large-sized country elevators, respectively. Out of the 39 surveys completed, three of the elevator locations were in northeast Oklahoma, 22 were in northwest Oklahoma, three were from the panhandle, and 16 were from southwest Oklahoma. Information reported from the country elevator survey in terms of location, scale numbers, testing equipment and elevator facilities is summarized in Table 2.

One question asked location mangers to report the required premium for implementing an IP system, taking into account the general requirements provided in the questionnaire. Out of the 39 locations surveyed, 29 reported premiums that would be required for establishing a precise, segregated and identity-preserved marketing system. Average premiums reported by elevator managers for each size category and for all respondents are presented in Table 3 for scenarios when identity-preserved wheat represents 5%, 25%, and 50% of the market share.

To determine if the premiums reported were significantly different from each other across different market shares; we regressed the reported premiums across all elevator sizes against the market share and tested whether the market share significantly explained variation in the reported premium by testing the significance of β_1 in equation 8:

$$(8) \qquad P = \beta_0 + \beta_1 MS$$

where

$P =$ Per bushel premium reported at each respective market share

$MS =$ Market share of identity-preserved wheat (5, 25, and 50%)

The procedure resulted in a t-value of -1.22 and p-value equal to 0.2265. This suggests that the surveyed managers would require about the same premium for identity-preserved wheat when IP wheat represents five, 25, and 50% of the market. Because there was no significant difference between premiums required when IP wheat represents differing market shares, we regressed the premiums reported at the five percent IP market share (most likely initial level) against variables pertaining to the capability of elevator locations for implementing an IP system.

Two models were chosen to determine if the number of truck scales, elevators, and grains currently being segregated significantly explained the variation in the required premium reported at a five percent market share. These variables were chosen because they exhibited the highest level of correlation with the premiums reported using Person Correlation Coefficients. The first model is summarized in equation 9. In the second model (equation 10) we added dummy variables to account for any variation of premiums reported due to elevator manager experience and education level.

$$(9) \qquad P_5 = \beta_0 + \beta_1 SCAL + \beta_2 ELV + \beta_3 GR$$

$$(10) \qquad P_5 = \beta_0 + \beta_1 SCAL + \beta_2 ELV + \beta_3 GR + \delta_4 D_{ft} + \delta_5 D_{ef} + \delta_6 D_{gf}$$

where

$SCAL =$ The number of scales at each location

ELV = The number of elevators at each location

GR = The number of different grains currently being handled at each location

D_{ft} = Equal to one if the elevator manger responding has five to ten years of experience, equal to zero otherwise

D_{ef} = Equal to one if the elevator manger responding has 11 to 15 years of experience, equal to zero otherwise

D_{gf} = Equal to one if the elevator manger responding has greater than 15 years experience, equal to zero otherwise

Parameter estimates, standard errors, p-values and R^2 values from equations 9 and 10 are summarized in Table 3.

Of the 39 elevator phone surveys completed, 27 (69.23%) were part of multi-location firms. Out of these multi-location firms surveyed, 18 (two thirds) identified that their most likely strategy for IP wheat marketing would be to designate one or more locations entirely to IP wheat. Out of the 39 elevators to which phone surveys were completed, the mean number of locations per firm was 4.2, which included those firms with only one location. Approximately 31 percent of all elevators locations surveyed were firms with only one location.

Of all small-sized and medium-sized locations surveyed, a majority reported that their biggest obstacle for developing a segregated and identity-preserved marketing system would be availability of bins and out of the ten large-sized locations that responded most identified commingling risks at loading and unloading as their biggest obstacle.

Implications of Enterprise Budget Results

Bullock and Desquilbet reported that in 2001 producers of identity-preserved, non-genetically modified soybeans were receiving approximately a $7.50/ton ($0.19/bu) premium paid by the elevators receiving non-GM soybeans. Using a 2001 average soybean price of $4.38

per bushel (NASS), this equates to a 4.3 percent premium. In 2001 the average price per bushel that producers received for all wheat was $2.72 (NASS). A 4.3 percent premium would generate approximately $0.13 per bushel. Additional costs from the enterprise budget estimates for non-Roundup Ready©, identity-preserved wheat ranged from $0.81 per bushel to $4.91 per bushel. When opportunity costs for not growing Roundup Ready© wheat were included in the additional cost of producing non- Roundup Ready©, identity-preserved wheat, estimates varied from $1.20 per bushel to $5.35 per bushel. This suggests that the premiums for IP, non-GM wheat would need to be much higher than those reported for non-GM soybeans in 2001.

Implications of Country Elevator Survey Results

Large-sized country elevator locations are probably the most capable of implementing a segregated and identity-preserved marketing system within their particular location. Small and medium-sized elevators both would be very inefficient from the standpoint of long incoming truck lines at the scale (both size categories reported an average scale per location of approximately 1). Small and medium-sized locations would find it very difficult to establish separate lines for IP and non-IP wheat during the heavy delivery times, reflected by the low number of elevator facilities per location. Large-sized elevator locations may be much better equipped to establish separate lines for identity-preserved wheat within their location and would have a lower risk of commingling as suggested by the higher level of scales, elevator facilities, dumping pits, and legs per location.

Results from the country elevator survey also suggest a majority of the elevator facilities at the locations surveyed are either totally cement or are a combination of cement and metal. Cement facilities have bins constructed very close to one another with grain storage in spaces between bins. Commingling on conveyor belts used to move grain laterally above and below the cement bins can occur very easily as grain remains in cracks and crevices after transfer, thus making identity-preservation within cement facilities very difficult.

Results from the regression analysis on required premiums suggest that there may be other factors that country elevator managers are using to estimate the cost of identity-preservation at country elevators. The low amounts of segregation and identity-preservation currently in the industry may have prohibited country elevator managers from making an accurate assessment of the additional costs they would incur when implementing an IP system. In addition, the small sample size in our study (39 locations) may have also contributed to the insignificance of specified variables.

Two thirds of all elevator locations that are members of a multi-location firm suggested that their firm strategy would most likely be designating one location completely to IP wheat. Past studies have looked at the transportation cost increases when one facility begins receiving only a particular type of grain. However, studies like Vandeburg have assumed farms would produce both IP and non-IP grain. Producers would have to ship one type (IP or non-IP) to a location with higher transportation costs, thus increasing total producer transportation costs. However, production in a region might adapt to correspond to the type of wheat accepted at the local elevator or elevators handling segregated wheat might locate in an area where that type of wheat is widely produced. Contract arrangements would help to ensure an adequate volume for the elevator and an adequate market for the producer.

Suggestions for Future Research

Variables specified in our analysis did not significantly explain the variation reported for premiums that would be required by country elevators for establishing an IP marketing system. Further research into costs incurred at country elevators for establishing an IP marketing system at country elevators would be valuable in determining the full cost of marketing identity-preserved wheat. Further research into different cropping options for isolation acres and their impacts on IP wheat production costs would be very beneficial. In addition, research into alternative arrangements among wheat producers to minimize barrier losses would be warranted. Finally, production budgets may need to be modified as additional information about testing requirements and technology fees becomes available.

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Table 1: Additional Costs for Producing IP Wheat

Area/Isolation Requirement	Including on-farm storage		Not including on-farm storage	
	C_{IP}	C_{IP+r}	C_{IP}	C_{IP+r}
Northwest-100 ft barrier	$1.06	$1.45	$0.81	$1.20
Northwest-300 ft barrier	$1.40	$1.79	$1.12	$1.51
Panhandle-100 ft barrier	$1.17	$1.56	$0.90	$1.29
Panhandle-300 ft barrier	$1.30	$1.69	$1.03	$1.42
Southwest-100 ft barrier	$1.08	$1.47	$0.82	$1.21
Southwest-300 ft barrier	$1.30	$1.69	$1.07	$1.46
Northeast-100 ft barrier	$1.89	$2.30	$1.42	$1.82
Northeast-300 ft barrier	$4.91	$5.35	$3.95	$4.39

C_{IP} = Additional per bushel costs of producing an identity-preserved wheat considering both the probability of commingling and the cost of selling the first 50 bushels of IP wheat harvested in a non-IP market ($/bu)

C_{IP+r} = Additional per bushel costs of producing an identity-preserved wheat considering the probability of commingling, cost of selling the first 50 bushels of IP wheat harvested, and the opportunity costs of not producing RR wheat ($/bu)

Table 2: Country Elevator Survey Statistics

	Small-Sized Locations[1] (14)	Medium-Sized Locations[2] (14)	Large-Sized Locations[3] (11)	All Locations (38)
Scales per Location	1.1	1.2	1.8	1.4
Manual Probe	11	7	6	24
Automatic Probe	3	7	5	15
Elev. per Location	1.6	1.8	2.5	1.9
Concrete	22.7%	40.0%	33.3%	32.4%
Metal	68.2%	32.0%	44.4%	47.3%
Combo	9.1%	28.0%	22.2%	20.3%
Pits per Location	2.4	3.1	4.7	3.3
Legs per Location	1.7	2.7	3.8	2.6
Pits per Elevator Facility	1.5	1.8	2.0	1.7
Legs per Elevator Facility	1.1	1.5	1.6	1.4
Employees per Location	4.8	8.9	10.1	7.6

1. Less than 500,000 bushels of total capacity
2. From 500,000 bushels to 999,000 bushels of total capacity
3. Equal to or greater than 1 million bushels of total capacity

Table 3: Mean Premiums ($/bu) Reported and Regression Results

IP Wheat Market Share	Small-Sized[1]	Medium-Sized[2]	Large-Sized[3]	All Locations Reporting Premiums
5%	0.532	0.377	0.450	0.446
25%	0.477	0.305	0.400	0.384
50%	0.451	0.250	0.425	0.356
Average	0.487	0.311	0.425	0.395

Equation Number (R^2 Value)	Variable	Parameter Estimate	Standard Error	P-Value
9	*SCAL*	-0.0894	0.1091	0.4202
(0.10)	*ELV*	-0.0257	0.1071	0.8126
	GR	-0.0630	0.0544	0.2578
10	*SCAL*	-0.0430	0.1050	0.6864
(0.32)	*ELV*	-0.0413	0.1005	0.6850
	GR	-0.0691	0.0508	0.1879
	D_{ft}	-0.4749	0.2862	0.1112
	D_{ef}	0.1318	0.2997	0.6645
	D_{gf}	-0.2588	0.2481	0.3082

1. Less than 500,000 bushels of total capacity
2. From 500,000 bushels to 999,000 bushels of total capacity
3. Equal to or greater than 1 million bushels of total capacity