Economics of Regulating Wheat Cleanliness

William W. Wilson
Professor
Department of Agricultural Economics

Daniel Scherping
Research Assistant
Department of Agricultural Economics

D. Demcey Johnson
Assistant Professor
Department of Agricultural Economics

David Cobia
Professor
Department of Agricultural Economics

The impact of quality on competition in the world wheat trade has been a subject of growing interest. While this is true for all exporting countries, wheat quality has been of particular interest in the United States because of losses in export market share during the 1980s. Much of this debate has been focused specifically on one characteristic – wheat cleanliness.

In the U.S. wheat marketing system, dockage is a nongrade-determining factor. In individual transactions, the level of dockage is a contract term which is subject to negotiation between buyers and sellers. Other countries include the equivalent of dockage as a grade-determining factor with stringent limits. The configuration of grade limits in conjunction with intergrade price differentials provides incentives to clean wheat in these countries. Proposals that limit dockage levels have been made in the United States. Specifically, the 1990 Farm Bill enables the Federal Grain Inspection Service (FGIS) to establish or amend grade standards to match levels of "cleanliness" offered by competing countries.

The Federal Grain Inspection Service (FGIS), through a cooperative agreement between the Economic Research Service (ERS) and selected land-grant universities, is analyzing the economic impacts of alternative means of regulating dockage levels in the U.S. grain marketing system for all major grains and oilseeds. North Dakota State University is analyzing hard red spring (HRS), durum, and white wheat and barley. This article provides a summary of four reports which analyzed different aspects of the wheat cleanliness problem.[1] The first publication, **Wheat Cleaning Costs and Grain Merchandising**, identifies dockage levels and cleaning costs at various locations in the marketing system. Characteristics of country and export elevators are presented, and merchandising practices are described. The second publication, **Wheat Cleaning Decisions at Country Elevators**, analyzes cleaning and blending decision issues at country elevators. A model is developed in the third publication, **Measuring the Impacts of Dockage on Foreign Demand for U.S. Wheat**, that can be used to evaluate the impact of dockage on import demand for U.S. wheat and to identify the optimal export strategy for individual foreign markets. The fourth report, **Impacts of Alternative Policies Regulating Dockage**, presents estimates of aggregate costs of alternative regulations, and discusses issues pertaining to the policy decision.

---

[1]These studies are available from the authors.

Wheat Cleaning Costs and Grain Merchandising

Dockage levels at various locations in the marketing system, merchandising practices that influence dockage levels, and cleaning cost estimates for HRS at country and export elevators are presented in Scherping et al. Key highlights from the report:

- Cleaning costs per bushel at country elevators have been fairly stable through time, but the amount of wheat cleaned fluctuates according to the level of dockage in harvested wheat. Typically, over 70 percent of production is cleaned.

- Cleaning costs for both export and country elevators increase as the wheat is cleaned to lower dockage levels (Figure 1).

  Economic-engineering cost estimates were derived for country and export elevators. These cost estimates were used to illustrate how different components affect cleaning costs.

- Average fixed costs are higher for country elevators than export elevators because of high investment costs relative to cleaning capacity (Table 1). A country elevator's variable costs are lower for two reasons. First, the value of "wheat loss" is generally less at country elevators than at export eleva-tors. Second, labor costs are lower at country elevators.

- Grain cleaner ownership involves high fixed costs relative to variable costs. An elevator that matches its cleaning capacity closely to its cleaning requirements will incur lower average fixed costs, e.g., depreciation and opportunity costs. Thus, higher utilization rates will decrease total average cleaning costs.

- Wheat loss is an important component of the cleaning cost. Specifically, it reflects the difference between the value of wheat and the screenings value of wheat that is lost during cleaning. Cleaning costs are directly related to the amount of this loss.
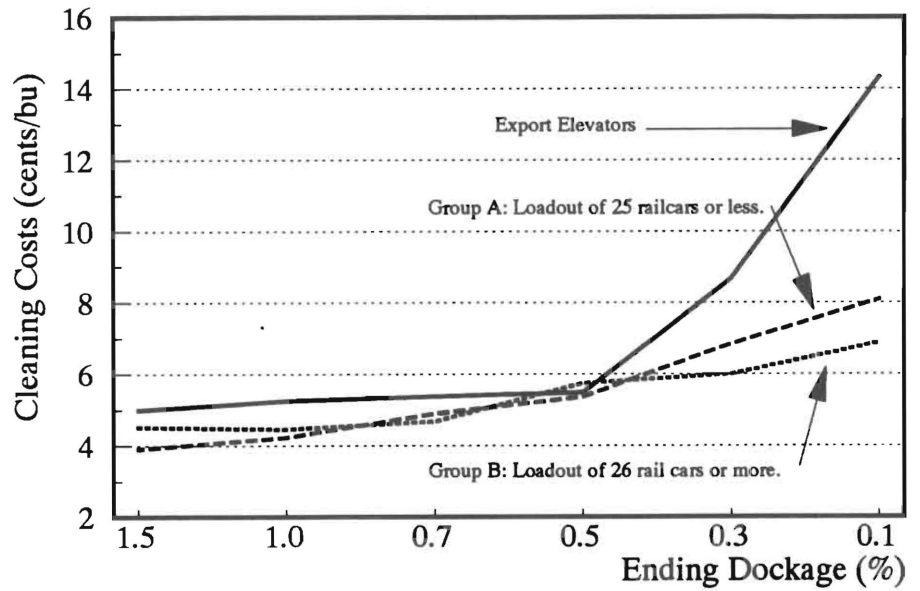

Figure 1. Wheat cleaning costs at export and country elevators, 1991 and 1990, respectively. Source: Scherping et al.

Table 1. Estimated wheat-cleaning costs from 3% initial dockage to 0.4% ending dockage, Upper Grain Plains, 1991.

| | Elevator[a] | | | |
| | Country | | Export | |
Item	Annual	¢/bu	Annual	¢/bu
Bushels cleaned[b]	700,000		4,200,000	
Fixed costs:				
Depreciation				
Cleaner	2,984	0.4	7,026	0.2
Install	2,984	0.4	7,026	0.2
Opportunity				
Cleaner	4,968	0.7	11,698	0.3
Install	4,968	0.7	11,698	0.3
TOTAL FIXED COSTS	15,904	2.3[c]	37,448	0.9[d]
Variable costs:				
Wheat loss[d]	6,644	0.95	95,785	2.3
Energy	955	0.13	1,836	0.04
Labor	1,079	0.15	61,250	1.5
Maintenance	350	0.05	700	0.02
TOTAL VARIABLE COSTS	9,028	1.3[c]	159,571	3.8[c]
TOTAL COSTS	24,932	3.6	197,019	4.7

[a] These cleaning costs refer to Cleaners C and E (rotary screen cleaners) for the country and export elevators, respectively, as defined in Scherping et al.

[b] Cleaning for 700 hours per year.

[c] Numbers do not add up because of rounding.

[d] Assuming 0.7% wheat loss and price differences between value of screenings and wheat are 2.26¢/lb and 5.43¢/lb for country and export elevators, respectively.

SOURCE: Scherping et al.

Elevators clean when it is economically profitable for them to do so. Benefits of cleaning include revenue from sale of screenings, transport savings, premiums gained/ discounts avoided, storage of dockage is avoided, increased aeration and drying efficiency, and reduced insect and mold problems. Only revenue from sale of screenings and transport savings were incorporated in this analysis because other benefits are not easily quantifiable.

- Revenue from sale of screenings and transport savings are combined with cleaning costs to determine cleaning margins (Figure 2).

- Cleaning margins are positively related to screening values, initial dockage levels, and transport rates.

Wheat Cleaning Decisions at Country Elevators

An optimization model to analyze cleaning decisions at country elevators is presented in Johnson et al. The analysis places cleaning activities within the broader framework of a blending and handling problem. The model incorporates detailed functional relationships to derive cleaning costs. With few modifications the model could be used in practice as a decision aid for cleaning, blending,

and handling. By incorporating alternatives to cleaning, i.e., blending from different bins and shipping wheat without cleaning, the model provides a pragmatic basis for assessing the impact of selected variables and for evaluating how alternative regulations would affect the economics of cleaning.

Model Features

Wheat cleaning activities add complexity to a blending and handling problem. Unlike most other wheat quality attributes, which can be altered through blending activities, the dockage levels in each bin can be controlled independently through cleaning operations. The elevator sells wheat on a dockage-deductible basis, that is, the sales price applies to weight net of dockage. Since freight charges are based on gross weight including dockage, the elevator realizes savings on freight costs by cleaning before shipment. In addition, material removed through cleaning operations (screenings) can be sold as animal feed. The sum of freight savings and screening values less the cleaning costs represents an implicit cleaning margin, which may be positive or negative. Positive implicit cleaning margins provide incentives to remove dockage from wheat before shipment.

The model was used to simulate impacts of proposed changes in dockage limits (Grades #1, #2, and #3 have 0.5% dockage; Grades #4 and #5 have 2.5% dockage) on a merchandising firm for two representative years, 1987 and 1990. The proposed change in grade standards would have affected the extent of cleaning activity in 1987. Under existing grade standards and base-case assumptions, the elevator had little incentive to clean. Introducing a dockage limit induces cleaning. Under new grade standards, the extent of cleaning in 1987 depended on the size of the price premium for Grade #3 – a larger premium induces more cleaning. In contrast, the change in grade standards did not affect cleaning in 1990. In that year the elevator had incentive to clean, even without a change in grade standards.

Thus, the proposed change in standards would have a significant impact only in 1987. Additional costs, of 0.7 cents per bushel (averaged over all bushels sold), would be incurred in 1987 so that all wheat could meet or exceed the Grade #3 limits. These are net costs, taking into account the value of wheat loss due to cleaning, returns from sale of screenings, and transport savings. Assuming no change in sale prices, the net costs of satisfying new grade limits would be reflected in compressed margins or (more likely) passed along to producers as lower elevator bid prices.

Measuring Impact of Dockage on Foreign Demand for U.S. Wheat

One of the perplexing issues concerning dockage regulations is the potential impact on import demand for U.S. wheat. For numerous reasons, historical data cannot provide much insight into this question. Similarly, most casual surveys would not yield convincing results. As an alternative, we developed a model that could be used to answer a number of questions related to the impacts of wheat cleanliness on import demand for U.S. wheat (Johnson and Wilson).
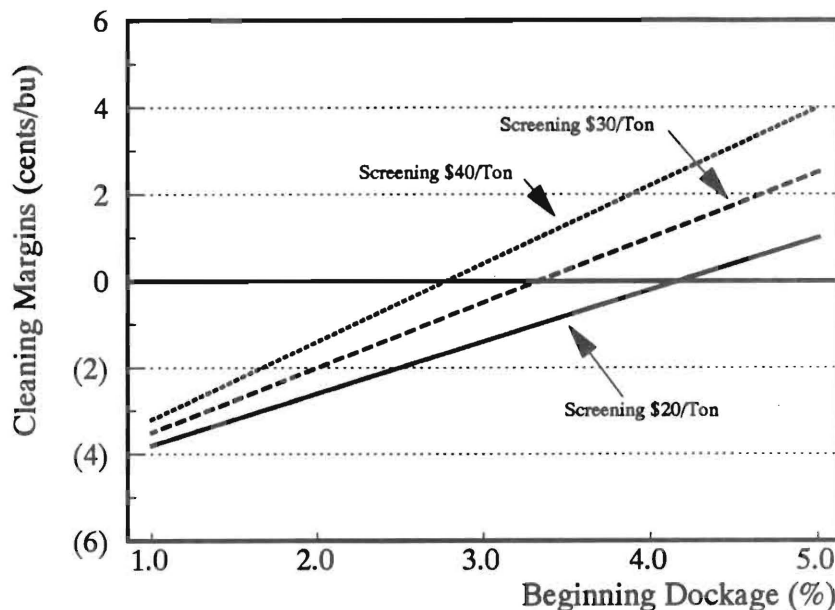

Figure 2. Cleaning margins with specified screening values, beginning dockage levels, and a cleaning and transportation cost of $.05/bu and $.60/bu, respectively, 1991. Source: Scherping et al.

Wheat cleaning is viewed as a processing activity which can occur at any number of points within the marketing system. Thus, cleaning activities within the exporting country must be competitive with cleaning activities in the importing country. At issue is the optimal location for cleaning, considering differentials in cleaning costs and screening values between the exporting and importing country, and transport and handling costs.

The model developed in the analysis provides a framework which can be used to answer the following questions: (1) How do dockage levels affect demand for U.S. wheat, and how does this vary across countries? (2) What is the "optimal" dockage level before export? and (3) Where in the U.S. marketing system is it optimal to clean wheat? Since factors impacting the value of cleaner wheat vary through time and, more importantly, across countries, generalizing about the likely effects of lower dockage levels on U.S. export market shares is difficult.

Simulation Results

The impact of reducing the dockage level contained in U.S. wheat on market shares is reflected in an importer's demand for cleaner wheat. This is affected by factors that can be quantified, such as the price of wheat and dockage level contained in purchases from the competitor country, the level of unmillable material required before milling, ocean shipping costs and tariffs, the cost of removing dockage, and screening values in the importing country.

For illustration purposes, the importer model is solved with two sets of parameters. Interviews with two foreign flour millers (from Thailand and Turkey) provided screening values, transport costs, tariffs, and cleaning costs. The quality attributes of U.S. and Canadian wheat are similar. Under these circumstances, the importer's requirements for protein, test weight, and moisture can be satisfied from either source, i.e., no constraints require blending U.S. and Canadian wheat. Thus, price and dockage are the critical determinants of import decisions.

Results of the analysis are summarized in Table 2. For Thailand, the optimal solution (from the perspective of the U.S. export firm) would be to clean more intensively, i.e., to 0.2 percent dockage and match the Canadian price. For Turkey, the United States should accept a price discount (relative to Canada) and avoid cleaning costs. In this case cleaning wheat in the U.S. prior to export is not competitive with cleaning and sale of screenings in Turkey.

Value of Cleaner Wheat and Importer Isocost Lines

The importer optimization model can be used to quantify the trade-off, from an importer's perspective, between price and incoming dockage. Differences in this trade-off exist across countries due to differences in tariffs, ocean freight costs, and domestic screening values. Results indicate that in the case of Thailand, buyers would be roughly indifferent between buying wheat at 0.9% dockage for $124.00/MT and .4% dockage for $124.65/MT. Thus, the buyer could pay a premium of up to $0.65/MT (1.8¢/b) for cleaner wheat and be equally well off. However, in the case of Turkey, the additional premium the buyer could pay for the reduced dockage level is only about $0.30/MT. Since the marginal costs of cleaning to this lower level exceeds this amount, the buyer would prefer the lower priced alternative with a slightly greater dockage level.

Different optimal solutions exist, depending on the importing country's characteristics. The optimal solution (from the perspective of the U.S. export firm) for Thailand would be to match the competitor's price and clean more intensively. For Turkey, the optimal strategy would be for the U.S. firm to offer wheat at a discount relative to the competitor and to avoid cleaning. With the quality requirements of Turkey and the relative costs and prices in this case, selling wheat at a discount is more profitable than cleaning before export.

Table 2. Summary of simulation results for importer and exporter model for HRS wheat.

| Model Solutions | Importing Country | |
	Thailand	Turkey
Optimal strategic variables —		
U.S. export price ($/MT)	125.0	124.5
U.S. dockage (%)	0.2	0.9
Objective function values —		
Importer's total cost ($000)	19,526.3	15,254.2
Exporter's net revenue ($000)	499.8	548.9

Optimal Location of Cleaning

The optimal location to clean wheat within the U.S. market system, at least in the case of wheat grown in North Dakota, is at the country elevator. This is due to the combined impacts of transport costs, differentials in the value of wheat and screenings, and cleaning costs.

Issues Related to Wheat Cleanliness and Import Demand

The analysis described in the previous section illustrates microeconomic determinants of import decisions with respect to price and quality attributes. Different types of demand behavior are due to end-use requirements, price/quality differentials between competing exporting countries, and costs of handling, transporting and cleaning, both in the exporting and importing countries.

However, data requirements for the model and, for that matter, any model that attempts to analyze strategic decisions related to this problem, are highly specific. Detailed information is required about quality requirements, cleaning costs, and screenings values in the importing country. To be more realistic, information about these values from competitor countries, in addition to transaction prices and other quality characteristics, are required also.[2] We

[2]See Wilson and Preszler for a discussion of the impacts of end-use quality characteristics and requirements and their distributions on import demand and exporter competitiveness.

have discovered that these informational requirements are excessive. Thus, our ability to draw global generalizations ascribing quantitative estimates of benefits attributable to increased exports from this model is limited.

This section provides a discussion of issues surrounding the impact of reduced dockage levels on import demand from a more aggregate perspective. These observations emanate from the results and experiences of developing the microeconomic model described earlier and from discussions with numerous importers and traders about this problem.

Market Segments and the Demand for Wheat Cleanliness

Foreign buyers have dissimilar demands for quality characteristics, which is evident from the diverse specifications in purchase contracts (Wilson et al). These differences are due to desired product characteristics in individual markets, levels of technological and commercial sophistication, and local competitive situations. Of particular importance in the case of dockage are the domestic marginal cost of cleaning, screenings value or the cost of disposal if appropriate, products produced, processing technology, and institutional procedures for importing. To the extent that these conditions vary across importing countries, the expected "value of clean wheat" to buyers and their potential response in terms of purchases also will vary. This makes any sort of aggregate measure of benefits associated with increased exports highly tenuous.

In countries where screenings are highly valued as animal feed, high dockage levels are more tolerable. By purchasing wheat that has not been cleaned intensively, an importer acquires screenings at the ocean freight cost plus domestic cleaning. Other countries (e.g., New Zealand and Taiwan) impute large costs to dockage because of environmental safeguards (i.e., avoidance of seed contamination or dust from cleaning operations). In these countries, buyers are willing to pay a greater premium for cleaner wheat to avoid or minimize

those costs that would be associated with intensive cleaning within the country.

The world wheat market can be viewed as being comprised of market segments, which can be used to describe demand for wheat cleanliness. A market segment is a group of buyers who respond similarly to the same stimulus. In this case, buyers are referred to as importing countries, though different segments also may exist within a country. The stimulus is cleaned wheat. The segment(s) that likely would expand purchases as a result of a U.S. policy requiring increased cleaning before export would be characterized as nonfeed, nonsubsidized markets in which processors are directly involved in purchase decisions. Additional sales to any other segments would be unlikely. We are not able at this time to identify potential size of these market segments so, enumerating the proportion of the market that would be sensitive to reduced dockage would be highly speculative.

Competitor Response

Another critical factor in assessing impacts of a change in U.S. policy toward wheat cleanliness is the likely response from existing competitors. The microeconomic model of import demand assumes existing competitor countries would have no response. However, from a competitive perspective, reduced dockage (or equivalently, any improvement in quality) should be interpreted as being equivalent to a price reduction. To the extent competitor countries respond, any benefits associated with improved exports resulting from this policy would be reduced. Specifically, as the probability of response by competitor countries increases, benefits attributable to expanded export sales decrease proportionately. In the extreme case (though as discussed below, very likely) where competitors respond simply by lowering prices, there would be no benefit in terms of expanded exports.

The likelihood of competitors responding is discussed here qualitatively. The general thrust of the policy change in the United States has been promoted as a means of matching a single quality

characteristic of competitors. This is an attempt to change the terms of competition. In response to reduced dockage in shipments from the United States and, therefore, improved value in some market segments, competitor countries would be forced to simply reduce price because (1) their cleaning costs are truly marginal; (2) they have built longer term marketing programs and sales strategies around cleanliness; and (3) at least in the case of Australia, one of the original motivations for the structure of their marketing system was for quality control. Specifically, improved cleanliness reduces infestation which was a problem in the 1960s (Wilson and Orr). The long-term result would simply be no change in the U.S. market share and a lower net purchase cost for importers.

This problem can be viewed in the context of competitive positioning and is illustrated in Figure 3, which shows the "ideal point" for different buyers, in this case, for two product attributes: wheat dockage and price. The ideal point represents a discrete reservation point between price and dockage level. The figure shows two segments to this market: One segment, S_1, has a preference for lower levels of dockage and is willing to pay a slightly higher price. Buyers in this segment would purchase any combination of price and dockage to the "northeast" of the ideal point represented by S_1. The second segment, S_2, represents a group of buyers who would prefer a slightly lower price and corresponding slightly higher dockage level. Also shown are hypothetical current offerings of two competitors, C_0 and U_0, representing the likely relative positions of some competitor countries and the United States, respectively.

In this case, buyers in S_1 would buy from C_0 and buyers in S_2 would buy from U_0. It is crucial that we do not know the size of the market segments represented by the area encircling S_1. Neither do we know the extent that a premium is received for the provision of cleaner wheat from the competitor country. If S_1 is too small relative to the supply available from C_0, then the competitor
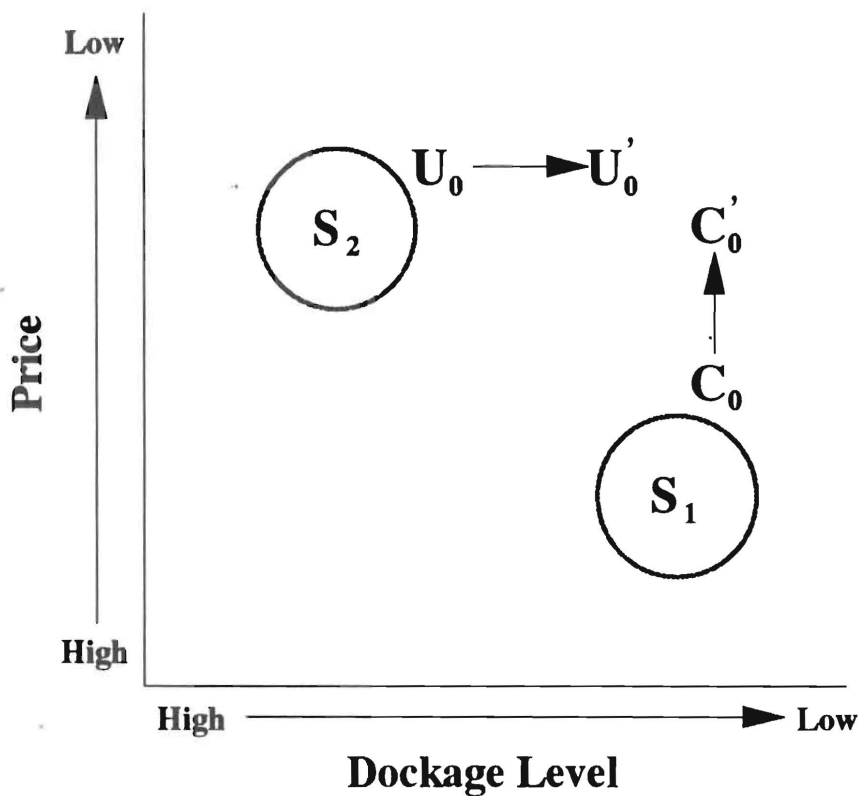
Figure 3. Competitive positioning and wheat cleanliness.

is forced to sell to buyers in S_2 at a discount relative to the price received from buyers in S_1. This is represented by the offering C.

The effect of the proposed policy shift for the United States would be to shift its offering to U, a point closer to the ideal point of buyers in market segment S_1. The effect of this is to improve the United States position relative to competitors, resulting in a more secure position with respect to S_2. Whether this increases sales to S_1 depends on the price and dockage level of U.S. wheat, relative to the ideal point, and how the competitor responds.

One alternative for the competitor's response to the change in U.S. offering would be to simply match the terms and continue serving S_1 at a lower price. Because of the change in U.S. policy, buyers in S_1 would have greater bargaining power with respect to the competitor. The other alternative would be for the competitor to abandon its policy and begin targeting S_2 directly with high dockage wheat at a lower price. The latter

alternative is highly unlikely. The more likely alternative would be to simply match the U.S. offerings and continue to serve their targeted markets, offering their residual supply to S_2 at a discount.

Conclusions and Discussion

Commercial treatment of wheat dockage differs drastically across exporting countries. In Canada and Australia, regulations ensure that only minimal dockage levels are contained in exports, and these are uniform for all importing countries. In the United States, dockage is not a grade-determining factor and competitive pressures serve as the regulatory mechanism. As such, the dockage level contained in particular shipments is subject to negotiation between individual buyers and sellers. Consequently, the dockage level varies across buyers and contracts, and normally an explicit or implicit premium is reflected in the value of shipments containing lower dockage levels. Dockage differs from other quality attributes because it can be controlled (removed) at several points in the

marketing system, including the point of processing (i.e., the foreign mill), and the by-product of the cleaning process can be sold.

Changes have been proposed for U.S. grade standards to reduce dockage levels to enhance competitiveness of U.S. wheat in world markets. In evaluating such proposals, understanding how individual firms discern cleaning decisions is crucial. This report provides a summary of a comprehensive study on the impacts of incorporating dockage as a grade-determining factor. Three previous reports discuss specific aspects of the problem and analysis.[4]

The first study (Scherping, Cobia, Johnson, and Wilson) describes how dockage is managed throughout the merchandising system. That report also derives estimates of costs of removing dockage at various points in the market system. Spring planted wheats are currently cleaned throughout the U.S. grain market system. The frequency of wheat cleaning of these classes is somewhat unique compared to others. Nearly all country elevators have cleaning equipment and regularly clean. Reasons for more frequent cleaning of these classes includes the level of incoming dockage is greater and costs of transport from the production region are higher. Head-to-head competition between these classes and comparable classes exported from Canada also result in pressure to clean. However, these classes could be cleaned more intensively.

The second study (Johnson, Scherping, and Wilson) develops an analytical model of cleaning decisions from the perspective of a typical country elevator in North Dakota. Critical factors that have an impact on wheat cleaning decisions are identified: cleaning costs, screening values, and transport costs. As these factors change, the margin associated with cleaning changes, resulting in a change in the optimal quantity cleaned.

---

[3]No intent is made here to summarize each of these reports. The body of this report contains summary points from each of these individual studies.

Johnson and Wilson provide a microeconomic model of wheat import decisions to determine the trade-off between price and dockage, and to determine the optimal strategy for a U.S. exporting firm. Alternatives include selling wheat that has not been cleaned extensively at a discount, or selling intensively cleaned wheat and trying to recoup cleaning costs through higher prices. Intensive cleaning before export must be competitive with the marginal cleaning costs and sale of screenings at the importing country. The results illustrate that, in general, countries with low cleaning costs, high domestic screening values, and low import tariffs would prefer to buy wheat at a slightly lower price and incur the cleaning costs domestically. Other countries with high cleaning costs, import duties, screening disposal costs, or low screening values would be willing to pay a premium to import wheat that has been cleaned intensively before export. Since these factors vary drastically across importing countries, generalizing about the extent that imports would increase as a result of regulated reductions in wheat dockage is exceedingly difficult.

Proposed regulations would increase costs to the industry. However, the costs are not as large as expected since these classes of wheat are already cleaned and equipment capital costs would not be incurred. The relevant costs are truly those of cleaning further from current levels to which wheat is already cleaned. The benefits, which are easily quantifiable, include transport savings and the sale of screenings. However for these classes, the marginal costs exceed these benefits, and the difference depends on the characteristics of the particular crop year. For a number of reasons, uniformly reducing the dockage level is not expected to increase exports of U.S. wheat. Most important is that competitors likely would respond to this type of policy with reduced prices, thereby nullifying the intended effect of the policy.

A number of other considerations, which are not quantifiable, are important in evaluating this change in policy. One is the impact of the policy on interchangeability of wheat lots. The U.S. market system depends on competitive bidding to determine the allocation of exports and handling activities across firms. The current policy allows exporters the flexibility of trading a large number of grade specifications to meet the needs of different end-users. While this provides buyers the option of pursuing greater specificity, it also potentially results in fewer competitors capable of supplying highly specific contract terms for every tender. One impact of particular importance in making dockage a uniform and restrictive grade factor would be to facilitate interchangeability of lots across traders to intensify competitive bidding.

Another indirect impact of regulating dockage levels that require more intensive cleaning would be an overall improvement in quality. In addition to the high levels of dockage in U.S. shipments, foreign buyers also point to high percentages of shrunken and broken kernels, as well as other undesirable factors. These were confirmed in simple correlation analysis (Wilson et al.). Significant and positive correlations were found between many grade-determining factors and the dockage level. Thus, removing dockage before export also can improve the overall wheat quality. In the context of the analyses reported in this study, these undesirable factors are reported as wheat loss, which increases with intensive cleaning. Fundamentally, by not cleaning as intensively, this potential wheat loss is implicitly sold for the price of wheat. This motive could be viewed as a component of a longer term strategy, which would have the impact of improving the reputation of U.S. wheat beyond simply the level of cleanliness which is reported in this study.

References

Johnson, D., D. Scherping, and W. Wilson. *Wheat Cleaning Decisions at Country Elevators*. Agricultural Economics Report No. 280, Department of Agricultural Economics, North Dakota State University, Fargo, February 1992.

Johnson, D., and W. Wilson. *Measuring the Impact of Dockage on Foreign Demand for U.S. Wheat*. Agricultural Economics Report No. 284, Department of Agricultural Economics, North Dakota State University, Fargo, February 1992.

Scherping, D., D. Cobia, D. Johnson, and W. Wilson. *Wheat Cleaning Costs and Grain Merchandising*. Agricultural Economics Report No. 282, Department of Agricultural Economics, North Dakota State University, Fargo, February 1992.

Wilson, W., D. Scherping, D. Johnson, and D. Cobia. *Impacts of Alternative Polices Regulating Dockage*. Agricultural Economics Report No. 285, Department of Agricultural Economics, North Dakota State University, Fargo, May 1992.

Wilson, William W., and Todd Preszler. *End-Use Performance Uncertainty and Competition in International Wheat Markets*. American Journal of Agricultural Economics pp. 556-63, August 1992.

Wilson, William W., and David Orr. *The Grain Marketing System and Wheat Quality in Australia*. Research Report No. 109, Department of Agricultural Economics, North Dakota State University, Fargo, 1989.