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IMPACTS OF ALTERNATIVE POLICIES REGULATING DOCKAGE

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Highlights

In the U.S. marketing system, dockage in wheat is a nongrade-determining factor. Other countries include the equivalent of dockage as a grade-determining factor with stringent limits. Similar proposals 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. This study evaluates economic impacts of alternative means of regulating dockage levels in the U.S. grain marketing system for hard red spring (HRS), durum, and white wheat. This report summarizes results from three related studies, and draws aggregate conclusions and implications.

Spring wheat is currently being cleaned to an average ending dockage level between 0.7% and 1.0%. A regulation which required the entire spring wheat production to be cleaned to an ending dockage level of 0.5% instead of 0.7% would incur the additional cost of $1.7 million and $4.9 million for HRS in 1987 and 1990, respectively. The same regulation with respect to durum would incur the additional cost of $0.6 million and $1.1 million in 1987 and 1990, respectively. These cost increase as wheat is cleaned to lower dockage levels. A regulation which required the ending dockage level for the entire spring wheat production be 0.2% instead of 0.7% would incur the addition cost of $4.7 million and $11.7 millon for HRS in 1987 and 1990, respectively. The additional cost of cleaning durum is $2.2 million and $2.6 million in 1987 and 1990, respectively.

These costs are probably not as large as for other classes since spring planted wheat is 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. Benefits, which are easily quantifiable, include transport savings and the sale of screenings. 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.

In contrast to competitor countries, the U.S. system depends on negotiations between buyers and sellers on individual transactions to determine contractual specifications that jointly meet their needs. In the case of dockage, this is the process in which the optimal level of cleanliness should be determined. However, in practice, the fact that in many cases buyers are not end-users precludes this system from working as intended.

An important impact of the policy is on interchangeability of wheat lots. The current policy allows exporters flexibility of trading a large number of grade specifications to meet the needs of different end-users. While this provides buyers with greater specificity, it also potentially results is 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. Foreign buyers, in discussing the higher levels of dockage in U.S. shipments concurrently describe the incidence of higher percentages of shrunken and broken kernels as well as other undesirable factors. These were confirmed in simple correlation analysis in this report. Significant and positive correlations were found between many of the grade-determining factors and the level of wheat dockage. Thus, removing dockage also can improve the overall quality of wheat before export. 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.

IMPACTS OF ALTERNATIVE POLICIES REGULATING DOCKAGE

William W. Wilson, D. Scherping, D. Johnson, and D. Cobia[1]

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 its reduced market share during the 1980s. Much of this debate has been focused specifically on one characteristic--wheat cleanliness.

In the U.S. marketing system, dockage in wheat 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. Similar proposals 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 1990 farm bill included the "Grain Quality Incentive Act of 1990," which mandated that the Federal Grain Inspection Service (FGIS) estimate benefits and costs of cleaning grains and the distribution of economic impacts. FGIS initiated a major study on this topic before making changes in grade standards with respect to dockage. The FGIS, through a cooperative agreement between the Economic Research Service (ERS) and selected land-grant universities, is studying 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 (NDSU) is studying hard red spring (HRS), durum, and white wheat and barley. Adam and Anderson report similar findings for hard red winter and soft red winter wheat.

Four reports were prepared analyzing different aspects of the wheat cleanliness problem.[2] This is the fourth report. The other three reports analyze micro-economic determinants of cleaning decisions. 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 current merchandising practices are described. The second publication, Wheat Cleaning Decisions at Country Elevators, analyzes cleaning and blending at country elevators. The third publication, Measuring the Impacts of Dockage on Foreign Demand for U.S. Wheat, develops a model 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.

This report summarizes these studies, presents estimates of aggregate costs of alternative regulations, and discusses issues pertaining to the policy decision. However, first, we review previous studies which have addressed broader policy issues.

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[1]Authors are professor, research assistant, assistant professor, and professor at North Dakota State University, Fargo.

[2]These studies are available from the authors.

Previous Studies[3]

The Food Security Act of 1985 mandated the Office of Technology Assessment (OTA) to study technologies, institutions, and policies that affect the quality of U.S. exports and to examine the grain marketing system of major export competitors with an emphasis on quality. Two reports were published from this study: Enhancing the Quality of U.S. Grain for International Trade and Grain Quality in International Trade: A Comparison of Major U.S. Competitors.

The first report examined the U.S. marketing system and some possible changes to enhance grain quality. A major contribution of that study was to establish that issues of quality go beyond grain standards. Within this grain quality system, there are important interrelationships among 1) variety development, 2) production, 3) harvesting, 4) storing, 5) handling, and 6) testing. Any discussion of policy options related to grain quality has to encompass all these factors.

Though the OTA study did not specifically address issues pertaining to wheat cleanliness or dockage, it did set forth three areas where policy options could improve U.S. grain quality: variety control, market intervention, and grain standards. Of particular importance is that of premiums and discounts, which are established in the U.S. market system through negotiation between buyers and sellers for measurable characteristics, provide an important function. Specifically,

> Efficient determination of price differentials is important because they essentially allocate grain across end-users and provide signals throughout the production and marketing system (p. 5).

It is through these premiums and discounts that the market responds and the optimal level of quality characteristics are provided. The OTA study also recognized the importance and difference between "grade-determining factors" and "nongrade-determining factors." Dockage is an example of the latter. Measuring a characteristic allows it to become specified in a contract. This facilitates development of premiums and discounts which provide incentives to produce the level of a characteristic, in this case dockage, desired by market participants.

The OTA study also included a survey of domestic and overseas buyers on issues related to wheat quality. Important points from that survey regarding wheat cleanliness included 1) Overseas buyers indicated the level of dockage was of greater importance than did domestic millers; 2) Overseas buyers ranked the level of dockage to be of lesser importance than all other grade-determining factors, except for contrasting classes and wheat of other classes; and 3) Overseas buyers were concerned over the lack of uniformity in U.S. wheat quality, with dockage being particularly important.

The second report provided detailed explanations about the operations of grain marketing systems in competitor countries with particular emphasis on quality. Specific

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[3]This section only discusses previous studies related to the broader policy issues pertaining to dockage. Other studies related to firm level economics of cleaning are discussed in Scherping et. al.

regulations related to dockage and incentive mechanisms that exist in Canada and Australia result in cleaner wheat than that exported from the United States. Most important is that a combination of regulations implied in grade factor limits and intergrade price differentials through the operations of their respective price support mechanisms yield incentives for removal of dockage within the market system. It is a combination of implied regulations and incentives which result in intensive cleaning of wheat before export.

The Secretary of Agriculture was required by the United States Grain Standards Act Amendments of 1988 to examine the effects of including dockage along with foreign material (FM) as a grade-determining factor. The Economic Research Service (ERS) and FGIS conducted a study to examine impacts of combining dockage and FM either as a grade-determining factor or as a weight-deductible discount. Results of this study were published in a report entitled: Economic Implications of Combining Dockage and Foreign Material in the Grading Standards for Wheat (Mercier et al.).

The study was conducted for the crop years 1984/85 and 1987/88 to determine the cost of combining dockage and FM as a single grade-determining factor. Wheat export shipments for which the combined dockage and FM exceeded 1.0 percent were regraded. Price differentials prevalent during the study (February 1989) were used to calculate the cost of lowering the numerical grade. Costs of combining dockage and FM as one grade-determining factor were $6.87 million and $7.79 million for HRS, $4.42 million and $3.59 million for durum, and $2.85 million and $1.32 million for white wheat for crop years 1984/85 and 1987/87, respectively.[4]

Combining dockage and FM as a single discount factor was conducted two ways: The first was to discount when the combined level of dockage and FM exceeded 1.0 percent. Discounts that were prevalent in the fall of 1988 were used to calculate costs. Costs of combining the two factors as a single discount factor were $3.89 million and $4.75 million for HRS, $5.21 million and $4.57 million for durum, and $1.93 million and $0.88 million for white wheat for crop years 1984/85 and 1987/87, respectively.

The second was by weight deduction. The weight of dockage and FM was deducted when it exceeded 1.0 percent, while levels lower than 1.0 percent were not deducted. The weight deduction was valued at the prevailing price for U.S. #2 export wheat (June 1988). The cost of combining the two factors and deducting by weight when the combined factors exceeded 1.0 percent was $2.72 million and $1.84 million for HRS, $2.96 million and $1.89 million for durum, and $0.80 million and $0.21 million for white wheat for crop years 1984/85 and 1987/87, respectively.

The ERS study stated that cleaning could reduce some of these costs. The study concluded that the cost of combining dockage and FM as a grade-determining factor would be between 0.1 to 0.6 percent of the annual value of export sales.

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[4]An important fundamental assumption of the methodology used in this study is that historical shipment data, that result from trading practices and regulations at the time, were regraded "as-if" merchandisers were operating under the proposed regulations. In other words, the implicit assumption is that market participants' behavior would be unchanged under the new regulatory regime.

Review of Supporting Studies on Wheat Cleanliness

As part of the overall project on wheat cleanliness, the NDSU Department of Agricultural Economics completed three separate studies, addressing specific topics related to the broader issue of wheat cleanliness. This section provides a summary of important points developed in those studies.

The first study described merchandising and cleaning practices in spring planted wheats. This study analyzed survey data on the costs of cleaning wheat and merchandising practices. In addition, an economic-engineering analysis of wheat cleaning was conducted.

Optimization models were developed in the other two studies to analyze potential impacts of alternative policies on market participants. Of particular importance was that proposed changes in the treatment of dockage in grain standards could fundamentally alter operating practices of market participants. Thus, use of historical data would be inappropriate to analyze these impacts. Rather, these models were developed to simulate market participants' likely responses to changes in their operating environment.

Wheat Cleaning Costs and Grain Merchandising

Dockage levels at various locations in the marketing system, merchandising practices that influence dockage levels, economic-engineering cleaning cost estimates, and cleaning costs at country and export elevators for durum, HRS, and white wheat are presented in Scherping et al. Below are highlights from the report.

1. Dockage Levels in the U.S. Marketing System. Dockage levels reflect production and climatic factors unique to a particular region. HRS and durum, spring seeded wheat which are grown in the same geographical region, typically have higher dockage levels than fall seeded wheat, like white wheat. In addition, dockage levels in spring-seeded wheat show great variation from year to year. The following points highlight dockage levels at various locations in the marketing system:

- Farm level average dockage levels for HRS and durum in the main production region have ranged from 0.8% to 2.3% and from 0.8% to 4.2%, respectively, from 1984 to 1990 (Figure 1).

- Average dockage levels from country elevators for HRS and durum was roughly 1.0% from 1986 to 1990 (Figure 1).

- Amount of dockage country elevators removed in the HRS and durum production region can be approximated by the difference between the average farm and country elevator dockage levels (Figure 1).

- Average dockage levels in exported wheat were less than nonexported U.S. #1 and #2 HRS, durum, and white wheat. Exported U.S. #3 HRS and white wheat had a higher average dockage level than nonexported wheat from 1989 to 1991.

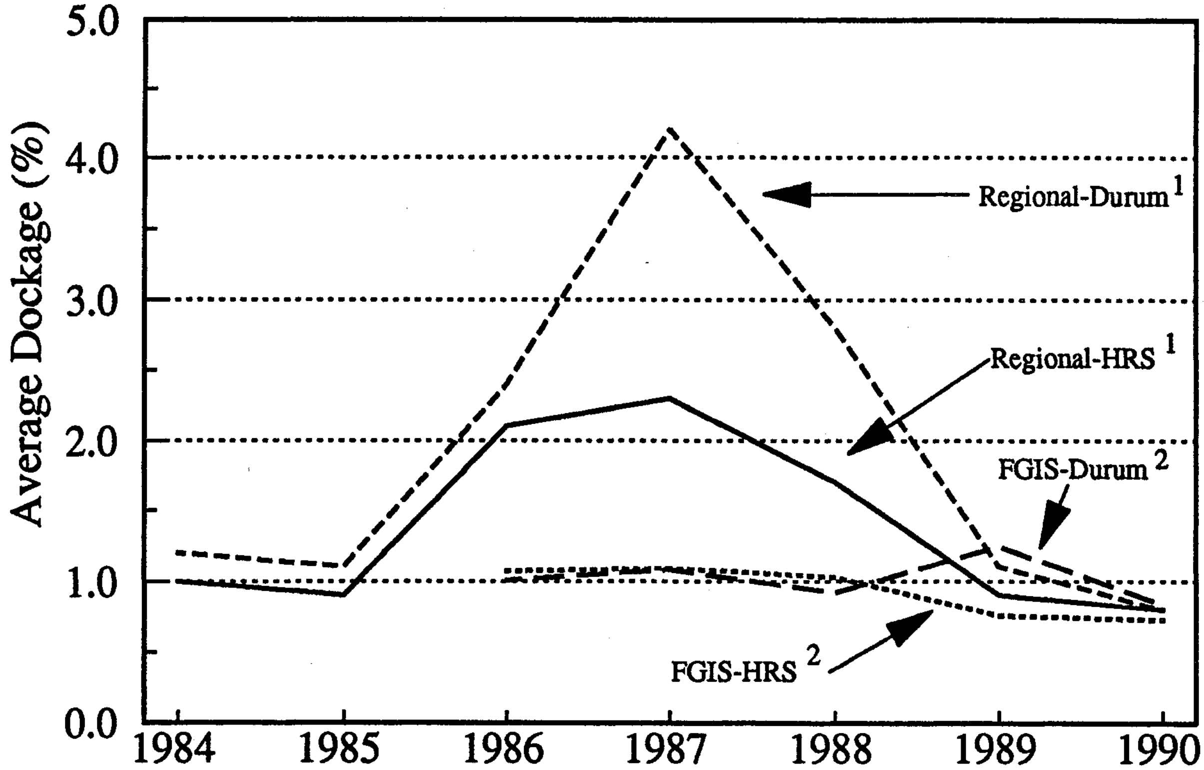

FIGURE 1 Dockage levels at the farm and country elevator level for durum and HRS wheat.
1. Regional: Samples obtained from farms or deliveries at country elevators -farm level.
2. FGIS: Submitted samples shortly after local harvest - country elevator level.

SOURCE: Department of Cereal Science and Food Technology and U.S. Department of Agriculture, FGIS. 1986-1990 U.S. Wheat Crop Quality.

2. Handling and Merchandising Practices. Handling and merchandising practices differ for elevators located in different regions because economic incentives vary across the marketing system.

- Elevators in the HRS and durum production region generally own and operate grain cleaners. However, elevators located in the white wheat production region generally do not own and operate grain cleaners (Table 1).

TABLE 1. PERCENT OF ELEVATORS THAT OWN AND OPERATE GRAIN CLEANERS FOR WHEAT, 1991

Operate Grain Cleaner	Durum & HRS Elevators	White Wheat Elevators
Yes	89.6	14.9
No	10.4	85.1

- Majority of export elevators do not own and operate cleaners capable of cleaning wheat.

- Country elevators in the HRS and durum production region clean a substantial proportion of the wheat handled (Table 2).

TABLE 2. CLEANING COSTS AND PERCENTAGE CLEANED BY COUNTRY ELEVATORS IN NORTH DAKOTA, AND DOCKAGE LEVELS OF THE HRS CROP, 1984-1990

Year	Cleaning Cost	Wheat Cleaned	Dockage Level for HRS North Dakota	Region[a]
	¢/bu	%	--------- %	---------
1990	4.4	70	1.0	0.8
1989	4.6	82	1.0	0.9
1988	4.0	85	2.2	1.7
1987	3.5	99	2.7	2.3
1986	4.0	95	2.0	2.1
1985	4.2	98	0.9	0.9
1984	3.5	100	0.9	1.0

[a]Regional area includes Minnesota, Montana, North Dakota, and South Dakota.

SOURCE: North Dakota State University and Department of Cereal Science and Food Technology.

- Country elevators in both the HRS and durum and white wheat production regions typically buy wheat on a weight deductible basis.

- Country elevators generally do not pass dockage discounts back to the producer.

- Domestic transactions beyond the country elevator sometimes have a "nonmilling discount" for dockage besides the weight deduction.

- Export elevators, especially those located at the Pacific Northwest, use discounts to discourage deliveries of wheat with high dockage levels. These discounts have come in response to some importers' stringent dockage limits.

3. <u>Cleaning Costs Estimated by Elevator Managers</u>. Country elevators in the HRS and durum production region and export elevators were surveyed about cleaning costs:

- Cleaning costs for country elevators were fairly stable through time and the amount of wheat cleaned represented over 70% of production (Table 2).

- Cleaning costs for both export elevators and elevators located in the HRS and durum production region increase as the wheat is cleaned to lower dockage levels (Figure 2).

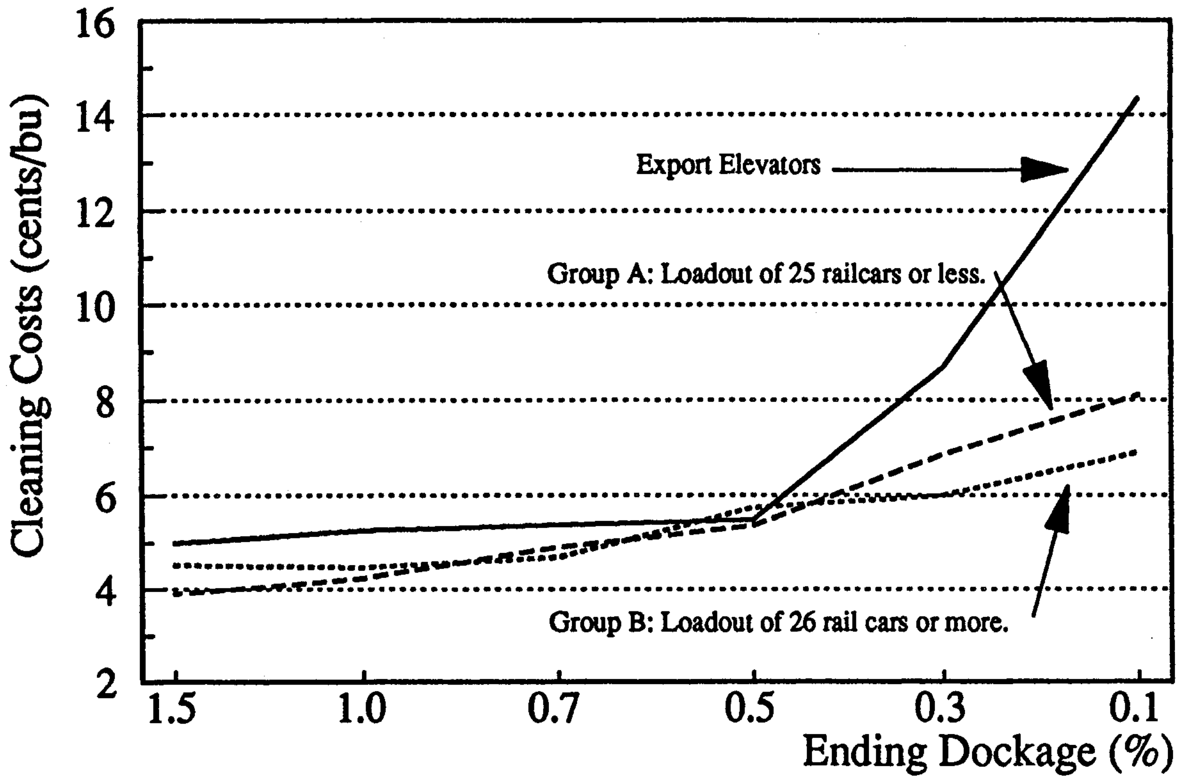

FIGURE 2 Wheat cleaning costs at export and country elevators, 1991 and 1990, respectively.

SOURCE: Scherping et al.

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

- Components of cleaning cost for a country and an export elevator are illustrated in Table 3. Average fixed costs are higher for country elevators because of high investment costs relative to cleaning capacity. A country elevator's variable costs are lower for several reasons. First, the value of wheat loss is generally less at country elevators than at export elevators because the wheat value is usually lower and the screenings value is greater. Second, labor costs were 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 (Figure 3).

- Wheat loss is an important component of the cleaning cost. Specifically, it reflects the difference between the wheat value and screenings value. Cleaning costs are directly related to the amount of wheat lost during cleaning (Figure 4).

TABLE 3. ESTIMATED WHEAT-CLEANING COSTS FOR A COUNTRY AND AN EXPORT ELEVATOR, ROTARY SCREEN CLEANERS CLEANING FROM 3% INITIAL DOCKAGE TO 0.4% ENDING DOCKAGE, 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 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.

5. Benefits of Cleaning. 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, increased storage capacity, 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 5).

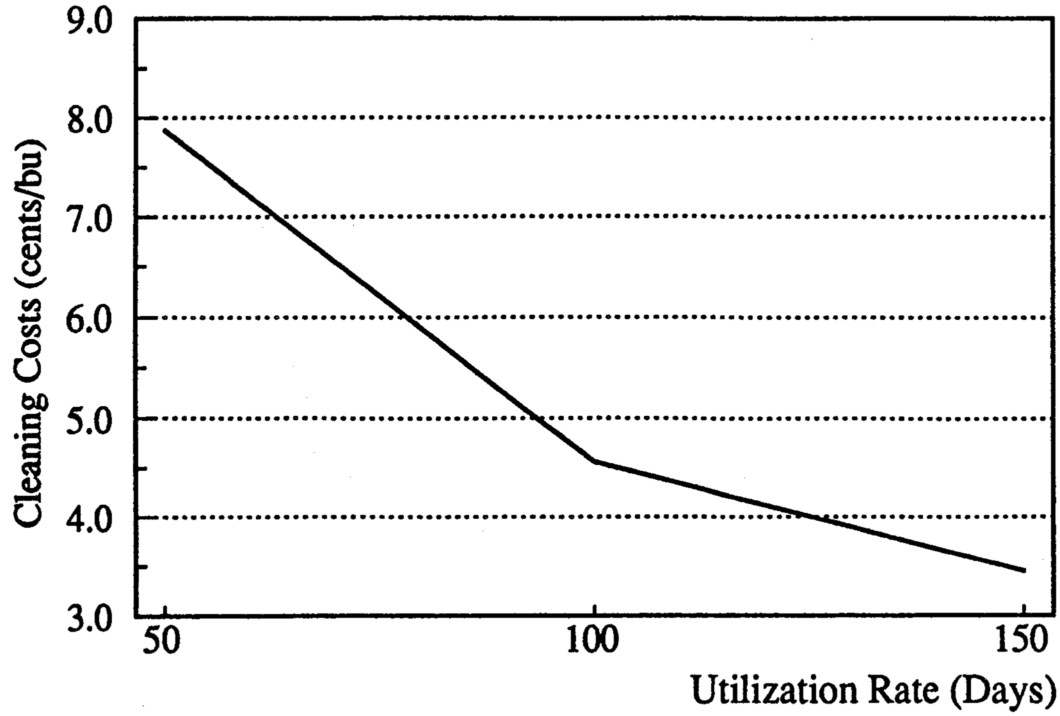

FIGURE 3 Effects of equipment utilization rate on cleaning costs for Cleaner A, with beginning and ending dockage levels of 3% and 0.7%, respectively, 1991.

SOURCE: Scherping et al.

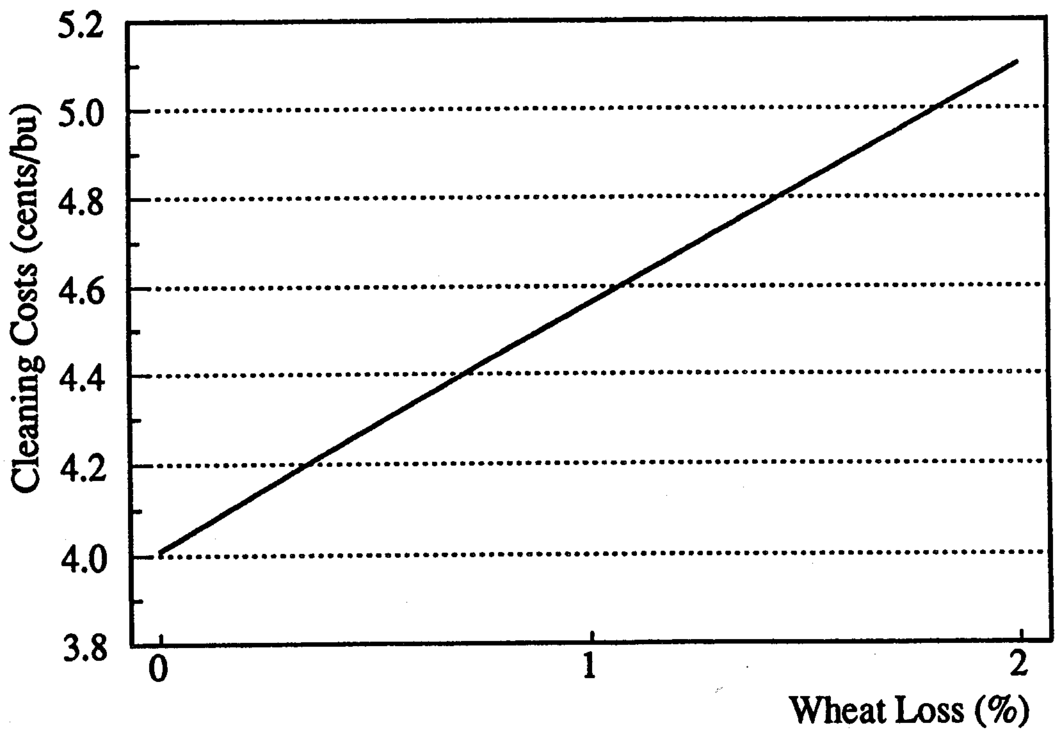

FIGURE 4 Effects of wheat loss on cleaning costs for Cleaner A, with beginning and ending dockage levels of 3% and 0.7%, respectively, 1991.

SOURCE: Scherping et al.

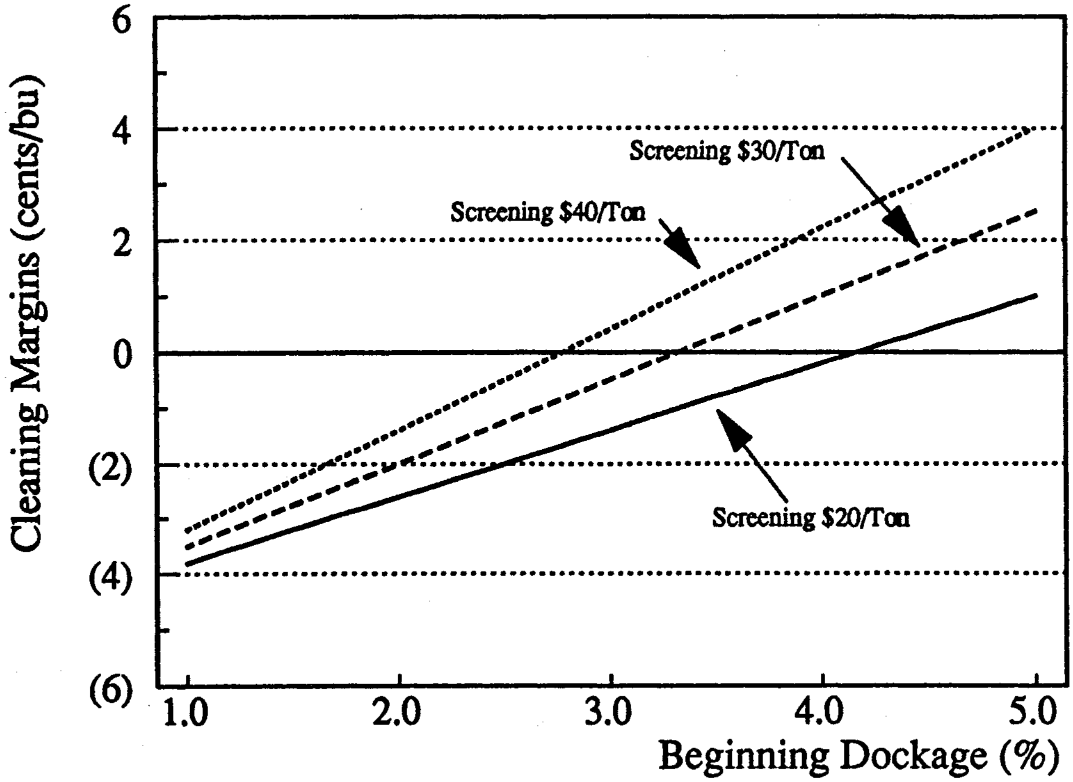

FIGURE 5 Cleaning margins with specified screening values, beginning dockage levels, and a cleaning and transportation cost of $.05/bu and $.60/bu, respectively.

SOURCE: Scherping et al.

- 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.

1. Model Features. Wheat cleaning activities add complexity to a blending and handling problem. Unlike other wheat quality attributes, which can be altered only

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.

2. Simulations Conducted For 1987 and 1990 Crop Years. The model represents a typical country elevator handling situation in North Dakota. Factors affecting cleaning and blending decisions are highly variable. Since prices and quality attributes of wheat available for blending vary over time, framing a "typical" cleaning/blending problem is inherently difficult. Our approach was to perform simulations with two different sets of parameters, corresponding to two different crop years, 1987 and 1990. Average dockage levels were high in 1987, and the screenings value was low, whereas the opposite was true in 1990. Simulation results for 1987 and 1990 illustrate the sensitivity of the model to these key parameters.

3. Factors Impacting Cleaning Decisions. The model is solved with different values of two key parameters--the screenings value and transport cost. These values influence incentives to clean directly. However, the extent of cleaning may shift from year to year, depending on overall dockage levels.

The screenings price has a pronounced impact on cleaning activity for both years. For screening prices below $15 to $20 per ton, the implicit cleaning margin apparently was negative: cleaning did not occur. Market and quality conditions of 1990 were such that a higher price for screenings was necessary to induce cleaning. This can be attributed to differences in throughput rates,[5] and higher levels of shrunken and broken kernels (which affect wheat loss).

Transport costs also affect cleaning margins. Higher costs induce more cleaning because of greater implied savings on freight. The combination of these two factors--transport costs and screenings value impact cleaning profitability.

4. Commercial Discounts. Contract premiums or discounts for wheat cleanliness also influence the incentive to clean. Premiums for cleaner wheat or discounts for lots with dockage exceeding a particular level, though not pervasive in current trading practices, may be used to induce more cleaning.

When a dockage discount is specified, the seller must analyze whether it is more profitable to accept the discount and avoid cleaning costs, or to avoid the discount by cleaning to satisfy the contract limit. The answer depends on the magnitude of the discount, the maximum dockage limit, dockage levels of the wheat in the bins, and blending possibilities.

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[5]When beginning dockage levels are low, producing a given volume of screenings entails cleaning a larger volume of wheat.

Simulations indicated that the discount level necessary to induce cleaning would have been larger under quality conditions of 1987, due to higher average levels of dockage and low screening values. Under 1990 quality conditions, discounts were required only to induce cleaning below 0.4 percent dockage.

5. Change in Grade Standards. The model was used to simulate impacts of proposed changes in dockage limits (Grades #1, #2, and #3 have 0.5% dockage; and Grades #4 and #5 have 2.5% dockage) on a merchandising firm. 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.

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 their 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).

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 in the importing country. At issue is the optimal location for cleaning, considering differentials in cleaning costs and screening values in the export and importing country and transport and handling costs.

The model developed in the study 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? Although categorical answers for all these questions are not offered in the study, an integrated framework for analyzing decisions of importers and merchandisers is provided, and the impact of critical parameters on the value of cleaner wheat is demonstrated. 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.

1. Model Features. Specifically, we formulated a cost-minimization problem in which an importer can buy wheat from the United States and/or from a competitor country. Dockage levels and other quality attributes differ by country of origin; the importer can purchase wheat from either or both sources, but wheat must be cleaned to a specified level before milling. Other quality constraints, reflecting end-use requirements, also must be satisfied. The model highlights the significance of quality and price differences for import purchase decisions and can be used to identify possible trade-offs between price and dockage. Further, it provides an analytical basis for intercountry comparisons.

In addition to the importer's optimization model, we developed a second optimization model from the perspective of a vertically integrated U.S. export firm. The firm seeks to maximize net revenue from a sale by choosing (among other things) the dockage level in wheat offered for export. The firm assembles wheat at an interior location and incurs domestic transport charges to an export facility.

Cleaning activities can occur at either or both locations; these are endogenously determined based on relative cleaning costs, screenings value at different U.S. locations, and transportation savings. Quantities exported are derived from the importer's cost minimization problem. The two models are solved jointly to determine the optimal dockage level contained in export shipments. This allows dockage to be viewed as an instrument of U.S. commercial strategy.[6]

2. Assumptions. A number of specific assumptions are critical to this analysis: 1) The importer minimizes net costs, which are defined as wheat cost net of dockage and cleaning costs; 2) The exporter maximizes profits; and 3) Competitor countries do not respond to changes in U.S. quality or prices.

3. 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 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, representing two countries. Interviews with two foreign flour millers (from Thailand and Turkey) provided screening values, transport costs, tariffs, and cleaning costs. Attributes of U.S. and Canadian wheat used in the analysis are shown in Table 4, and specific characteristics for Thailand and Turkey are shown in Table 5.

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

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[6] The model was developed to allow for additional quality characteristics and constraints, which could be added. However, data limitations precluded us from incorporating them in the analysis at this time. To the extent the differences are restrictive, the sensitivity of import demand to price and dockage would decrease.

TABLE 4. QUALITY ATTRIBUTES AND IMPORT COSTS USED IN SIMULATIONS

Item	Country	
	Canada	U.S.
Protein (%)	14.46	14.52
Dockage (%)	0.24	*
Test weight (lb/bu)	60.90	60.47
Moisture (%)	12.48	11.96
Price ($/MT)		
f.o.b. export port	125	*

*Determined endogenously.

TABLE 5. CLEANING COSTS, OCEAN FREIGHT, AND TARIFFS USED IN SIMULATIONS

Item	Country	
	Thailand	Turkey
Handling cost ($/MT)	0.2	2.5
Cost per hour ($)	24.0	0.0
Rated capacity (MT/hour)	27.3	27.3
Wheat loss factor	1.5	1.5
Price of screenings ($/MT)	40.0	28.0
Ocean freight ($/MT)		
From United States	29.0	25.0
From Canada	29.0	25.0
Import duty ($/MT)	40.0	0.0

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.

4. Results of the analysis are summarized in Table 6. 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 U.S. should accept a price discount (relative to Canada) and avoid cleaning costs. In this case, the buyer would be unwilling to pay for cleaning wheat for a number of reasons, but fundamentally because it is not competitive with cleaning domestically and local sale of screenings.

5. Value of Cleaner Wheat and Importer Isocost Lines. This model can be used to quantify the trade-off, from an importer's perspective, between price and incoming dockage. Importer isocost lines are shown in Figures 6 and 7. Each line is a locus of points (U.S. price and dockage level), representing equivalent value to the importer. Movements to the northeast are associated with higher costs to the importer, including cleaning costs. Curvature of the lines depends on cleaning-cost parameters and on dockage levels supplied by competing exporters.

TABLE 6. SUMMARY OF SIMULATION RESULTS

	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

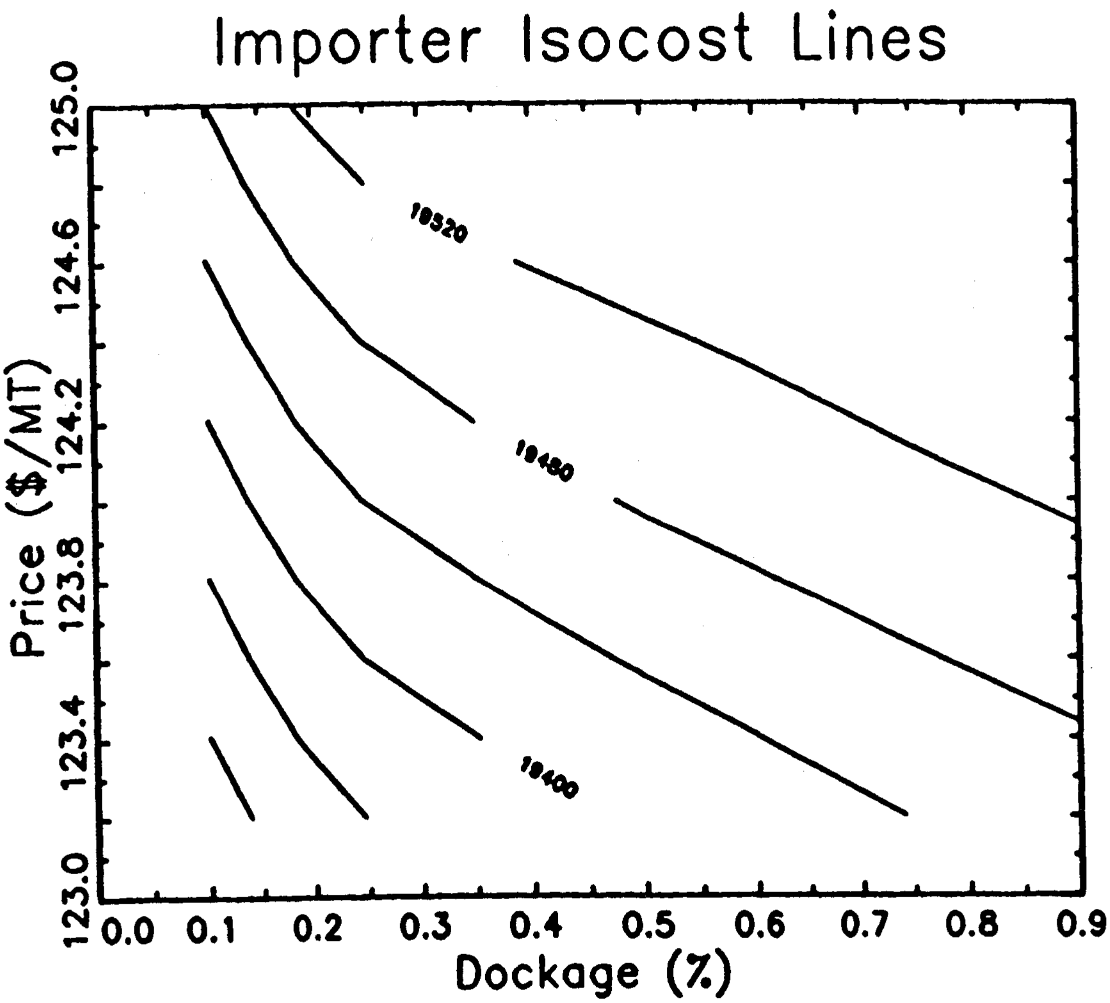

Figure 6 Trade-off Between U.S. Price and Dockage, Thailand

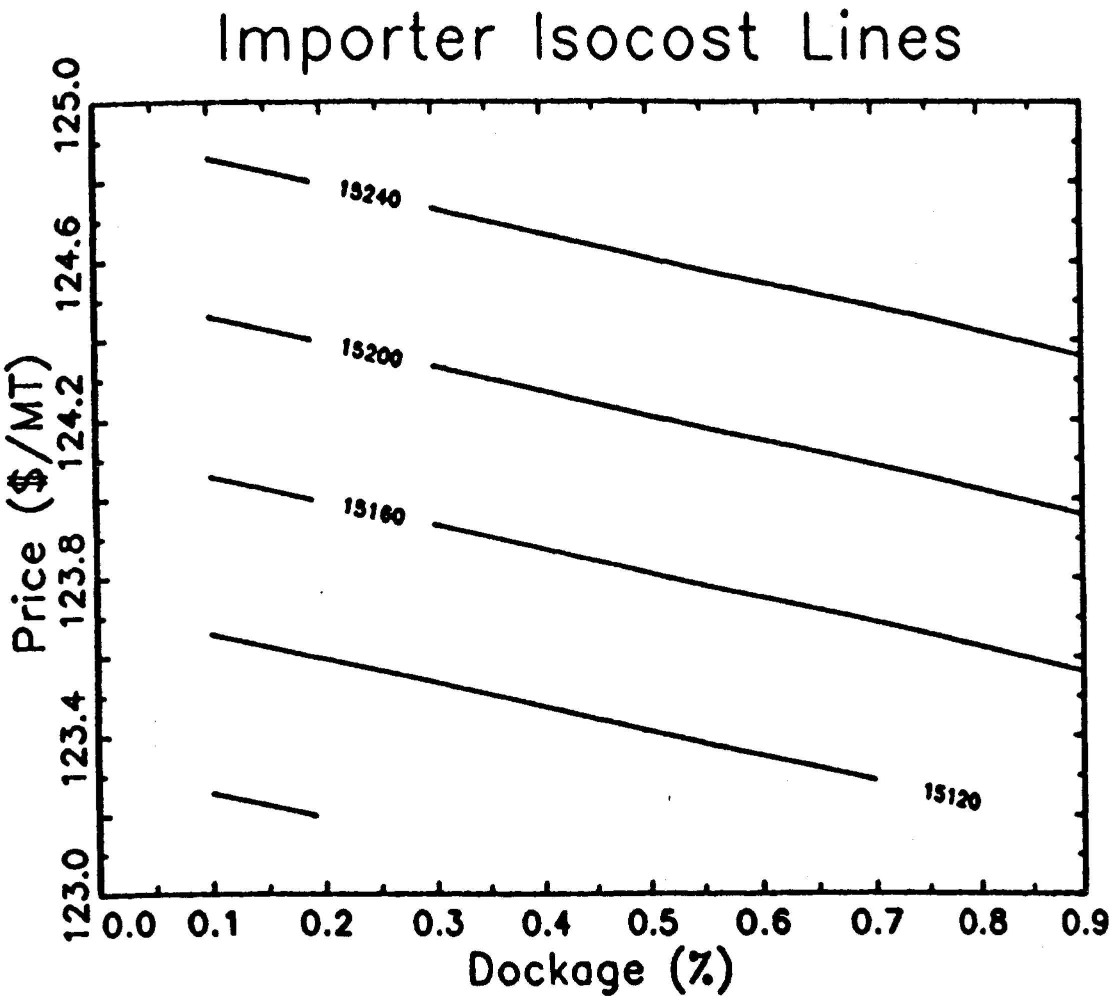

Figure 7 Trade-off Between U.S. Price and Dockage, Turkey

The isocost lines are steeper for Thailand than for Turkey. This reflects differences in tariffs, ocean freight costs, and domestic screenings value in the two countries. Moreover, cleaning costs (exclusive of wheat loss) in Thailand are sensitive to the level of incoming dockage, while those in Turkey are not. 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 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 $.30/MT. Since the marginal costs of cleaning to this lower level exceeds this amount, the buyer would prefer the lower priced alternative with 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.

6. 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 screenings value, and cleaning costs.

7. Limitations. This analytical framework has a number of important limitations. First, the results are highly specific to particular countries. A number of factors are identified that affect demand for cleaner wheat, including screenings values, cleaning costs, and requirements before milling. These vary substantially across countries. Hence, as a tool for "aggregative" analysis (e.g., examining the global impact of proposed dockage regulations), the framework would require highly specific information from a large number of individual markets.

Second, the importer model is based on an objective of cost minimization that includes cleaning costs before milling. This is acceptable for countries where the importer (buyer) and the end-user are the same. However, in numerous countries (such as the former USSR, China, Algeria, and Mexico), either the importing agency is not an end-user or end-users potentially have a limited influence on the specification of quality limits. In these countries, the appropriate objective may be to minimize gross import cost (i.e., excluding cleaning and sale of screenings). These countries would likely respond more to international price differentials than to relative dockage levels and other quality parameters.

Third, the analysis was conducted on the assumption that competitor exporting countries do not respond. This assumption implies that reducing the dockage level in U.S. wheat exports would not precipitate a lower price from competitor countries to retain their market share. Relaxing this assumption would result in no gains for the United States, it would simply reduce costs for the importer.

Issues Related to Wheat Cleanliness and Import Demand

The study 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. An integrated framework for analysis of cleaning decisions at each stage of the marketing system is provided by Johnson and Wilson.

However, data requirements for the model and, for that matter, any model that attempts to analyze microeconomic decisions related to this problem, are highly specific. Detailed information is required minimally about quality requirements, cleaning costs, and screenings values in the importing country. To be more realistic, detailed information about these values from competitor countries, in addition to transaction prices and other quality characteristics, are required.[7] We 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.

1. Comparing United States and Canadian Wheat. Differences do exist in grade factors values for spring planted wheats between the United States and Canada in some import markets, particularly in Japan and Taiwan.[8] Averages for dark northern spring (DNS) and Canadian western red spring (CWRS) are shown in Table 7. Values in North Dakota for the same crop years used in this study are compared to values at the point of import in these two markets, and the correlation coefficient between dockage level and other grade factors (Table 8). These results indicated a number of important observations:

TABLE 7. MEAN VALUES OF SELECTED GRADE FACTOR CHARACTERISTICS OF WHEAT AT DIFFERENT POINTS IN THE MARKET SYSTEM

	North Dakota		Taiwan[a]		Japan[b]	
	HRS 1987	HRS 1990	DNS 14.5%	CWRS 13.5%	DNS 14.0%	CWRS 13.5%
Protein	14.18	14.24	14.36	13.98	14.03	14.07
Dockage[c]	1.72	0.95	0.68	0.18	0.85	0.14
Shrunken & broken	1.02	1.18	1.76	1.68	1.39	0.95
Foreign material	0.21	0.06	0.12	0.07	0.34	0.20
Damage	0.56	0.55	N/A	N/A	0.54	0.40
Defects	1.75	1.79	N/A	N/A	2.27	1.55

[a]Shipments from 1985 through 1990.
[b]Shipments from 1981 through 1991.
[c]Average dockage level is not weighted by volume.

SOURCE: U.S. Wheat Associates in cooperation with the buyers in these respective countries.

[7]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.

[8]These data have been collected by U.S. Wheat Associates and in cooperation with the buyers in these respective countries.

TABLE 8. CORRELATION OF SELECTED GRADE FACTOR CHARACTERISTICS WITH DOCKAGE

	North Dakota		Taiwan[a]		Japan[b]	
	HRS 1987	HRS 1990	DNS 14.5%	CWRS 13.5%	DNS 14.0%	CWRS 13.5%
Test weight	-.30*	-.31*	-.05	-.36	-.15*	-.16*
Shrunken & broken	+.23*	+.20*	+.36*	+.16	+.30*	+.24*
Foreign material	+.26*	+.37*	+.19	-.38	+.44*	+.05*
Damage	+.15*	+.21*	N/A	N/A	.00	+.03*
Defects	+.35*	+.32*	N/A	N/A	+.31*	+.29*

[a]Shipments from 1985 through 1990.
[b]Shipments from 1981 through 1991.
*Indicates significant at the 10% level.

SOURCE: U.S. Wheat Associates in cooperation with the buyers in these respective countries.

- The dockage levels in North Dakota exceeds that in the import markets, indicating the extent of cleaning that occurs. However, the dockage level in DNS exceeds that for CWRS for both importing country. The dockage level in DNS imports by Taiwan is less than that in Japan, likely due to their contractual specification.

- For other characteristics, values for CWRS are only slightly better than that of the United States.

- Correlation coefficients between dockage and other grade factors are of particular interest. First, correlation coefficients at different points in the market system are fairly constant for DNS. Second, correlation coefficients between dockage levels in DNS and other factors are significant. These suggest that lower dockage levels are correlated with lower amounts of shrunken and broken kernels, foreign material, and defects. Each of these are statistically significant and important to end-users because of their impacts on extraction and mill efficiency.

- Detailed examination of this data indicates that the dockage levels contained in DNS has declined through time. Specifically, in Japan it declined from an average of about .90% during 1980-1984 to .73% and .61% in 1989 and 1990, respectively. The average dockage level in DNS imports by Taiwan has decreased from .88% in 1985 to an average of .65% during the period 1986 to 1990.

2. Other Observations. A number of important points need reiteration about the United States and international market systems related to dockage:

- With few exceptions (listed below) international wheat buyers can buy wheat with highly specific and reduced dockage levels from the United States. Since the change in procedures for "rounding," which went into effect in 1987,[9] buyers working with their suppliers can specify dockage to the nearest 1/10% in contracts. In addition, they can specify limits and/or premiums and discounts for deviations from some designated quantity.

- Examples of some contractual specifications regarding dockage are shown in Table 9. Specifications for dockage in export contracts vary across countries. Wheat is often purchased on a "clean basis," that is, with dockage weight deducted. Some buyers (e.g., the Philippines) deduct dockage above a specified level. Other buyers (e.g., Taiwan) purchase wheat on a clean basis but also apply penalties for dockage above levels specified in the sales contract. Still other countries make no specification at all for dockage, implying that gross weight (including dockage) is used for settlement.

TABLE 9. DOCKAGE CONTRACT SPECIFICATIONS FOR PRINCIPAL BUYERS OF HRS, 1991

Country/Agency	Dockage Specifications
Algeria	all dockage deductible, 1.0% maximum
Columbia	all dockage deductible, 1.5% maximum
Japanese Food Agency	0.5% dockage nondeductible
Korea	dockage deductible
Taiwan	clean basis - dockage all deductible plus an additional penalty for all dockage based off contract price
Philippines	0.5% dockage nondeductible
China[a]	0.1% dockage nondeductible, 0.1% maximum; excess dockage all deductible
USSR	0.5% dockage nondeductible, no maximum
PL480 tender	no mention of dockage

[a]This specification deducts dockage after the first 0.1%.

SOURCE: U.S. Wheat Associates.

[9]Before this time, dockage was rounded down when reported on certificates. Consequently, dockage was always underreported. Thus, implicit incentives existed to only clean or blend to the dockage limit, as opposed to the dockage that was reported.

- The market system provides positive incentives to clean HRS and durum wheat, independent of contractual specifications. In addition, grain-handling firms have responded with expanded capacity to accommodate additional cleaning to meet particular buyers' specifications before loading.

- Survey results of domestic buyers indicate that regardless of the incoming dockage levels, wheat is cleaned before milling. Conversations with overseas buyers confirm that similar operating practices exist in their countries. Thus, wheat cleaning before export must be competitive with cleaning and resale of screenings in the importing country. The question is how intensive should wheat be cleaned before export, recognizing that additional cleaning inevitably will be conducted within the importing country before milling.

3. Impediments to Contractual Specifications. The philosophy behind the U.S. grading system depends on contractual specifications for both grade and nongrade determining factors (e.g., dockage). Negotiations between buyers and sellers on individual transactions should result in contractual specifications that jointly meet their needs. In the case of dockage, this is the process in which the optimal level of cleanliness should be determined. The optimal level likely would vary across importing countries as well as through time. However, in practice, a number of impediments may prevent this process from working effectively:

- Buyers are not always the end-user: In many cases, individuals charged with procurement responsibilities for an importing country are not end-users. This is important since the end-user (in this case, the miller) must determine the optimal level of cleanliness. In an unfettered market system, these values can and are normally conveyed as contract specifications. However, if the end-user is not the direct buyer and/or has negligible impact on the buying process, contract specifications may not represent those that would be optimal. This is a problem in many countries in which wheat is procured through government buying agencies. This problem is not limited to purely government procurement agencies. Situations also exist in which the end-user is affiliated in some way with a trading firm whose responsibilities entail procurement. If that trading firm is not directly involved in grain handling and simply procures wheat through competitive bidding, end-user demands may not be reflected in contractual specifications and in the quality received. The procurement firm may try to exploit economies of large-scale purchases of homogenous wheat lots, which may not be in the end-user's interests.

- Bidding Competition: The U.S. grain marketing system depends on bidding competition as a mechanism to allocate sales among and between grain exporters. This is a basic tenet of the U.S. grain marketing system and contrasts sharply with that of competitor countries, which have single-seller agencies. Competition among bidders is directly related to the number of bidders.[10] Contracts with less specificity generally attract a greater number of bidders. Thus, importers striving to increase the intensity of competitive

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[10]See Preszler, Wilson and Johnson for a discussion of these points.

bidding have a tendency not to require specifications that would limit the number of bidders.

Contracts with greater specificity, such as tighter dockage specifications, result in fewer eligible competitors in the bidding process. This increased quality specificity has the potential to decrease bidding competition intensity. Thus, buyers are forced to assess a trade-off between the intensity of bidding competition and contract specificity.[11]

4. 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. 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 is the domestic marginal cost of cleaning, screenings value or the cost of disposal if appropriate, products produced, processing technology and institutional procedures for importing. If these 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 intensely, 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) and corresponding high disposal costs. 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. These are delineated in Figure 8. Four bases for segmenting the market are used to illustrate the differences.[12]

The first basis is to distinguish by end-use, in this case, between feed and nonfeed uses. This is included to acknowledge the feed component of the market likely would not expand purchases because of improved cleanliness. The second basis separates the

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[11]This problem is further exacerbated in administering some of the export programs that depend on competitive bidding and release of information. Heterogenous contract specifications are more difficult to administer because of difficulty in assessing alternative bids.

[12]Other bases could be introduced, but they would unnecessarily complicate the analysis. These include more specific products produced (instead of the fairly gross distinction between feed and non-feed uses), and processing technology.

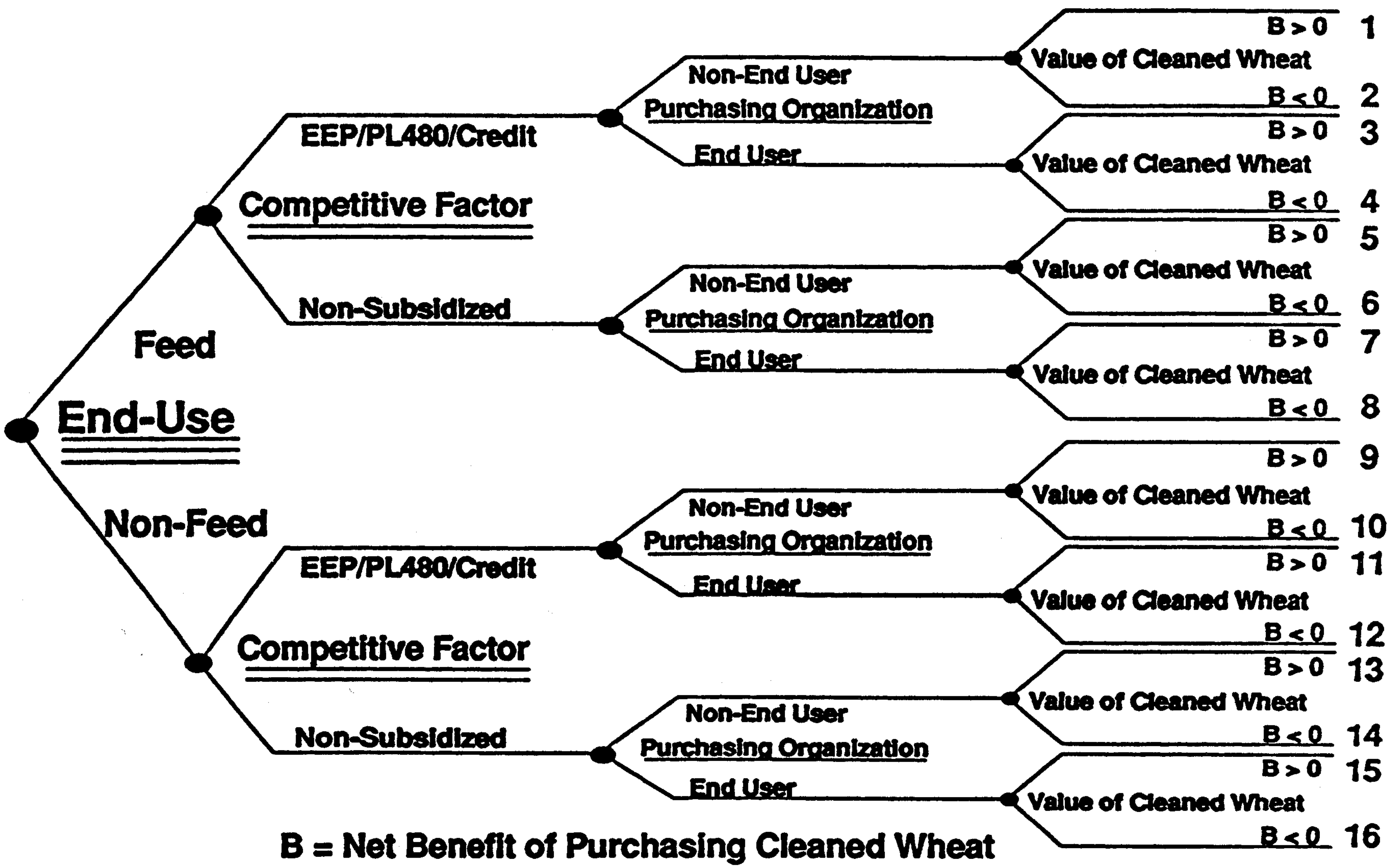

Figure 8 Segmenting International Wheat Market Demand for Wheat Cleanliness

market according to a competitive factor, in this case, to distinguish between those markets in which there is intervention in the form of direct or indirect export subsidies. The motivation for including this is that existing price and credit differences in these markets are sufficiently great that the impact of cleaner wheat likely would not expand sales.[13] In other words, these interventions result in disparities, which may override a buyers' calculation of benefits of purchasing cleaned wheat.

The third basis for segmentation is the purchasing organization. Based on discussion in the previous section, it follows that only those countries in which end-users are directly involved in purchasing and determining contract specifications (or have a great deal of influence) would demand for wheat cleanliness be conveyed in the form of increased purchases. In other countries, demand for wheat cleanliness likely would not be reflected in purchase contracts and, therefore, impact purchase decisions. The final factor is the value of cleaned wheat, which was the focus of the microeconomic model of wheat purchase decisions. As discussed in previous sections, this is determined by a number of factors, which are potentially unique to each importing country. Only in the case where the net benefit of purchasing clean wheat is positive ($B>0$) would cleaner wheat increase purchases.

The purpose of this illustration is to identify segment(s) that likely would expand purchases as a result of a U.S. policy requiring increased cleaning before export. In the context of this figure, segment 15 would be that which would most likely expand purchases. This segment is characterized as nonfeed, nonsubsidized markets in which end-users are directly involved in purchase decisions and in which the net benefit of purchasing cleaned wheat ($B>0$) is positive. If consideration is made for a period of time during which EEP and other interventions are not important market features, then segment 11 would converge to be identical to segment 15, resulting in greater specificity on contract terms. Additional sales to any other segments would be unlikely.

We are not capable at this time to identify potential size of these market segments. Thus, enumerating the proportion of the market that would be sensitive to reduced dockage would be highly speculative.

5. 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.

[13]Our microeconomic model demonstrates that buyers' demand for clean wheat can shift on small changes in relative prices.

The likelihood of competitor's 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 9, 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 concept 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 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_0^*.

The effect of the proposed policy shift for the United States would be to shift its offering to U_0^*, 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 for U.S. wheat, if the dockage level equals the ideal point, and how the competitor responds.

One alternative for the competitor's response to the change in U.S. offerings 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.

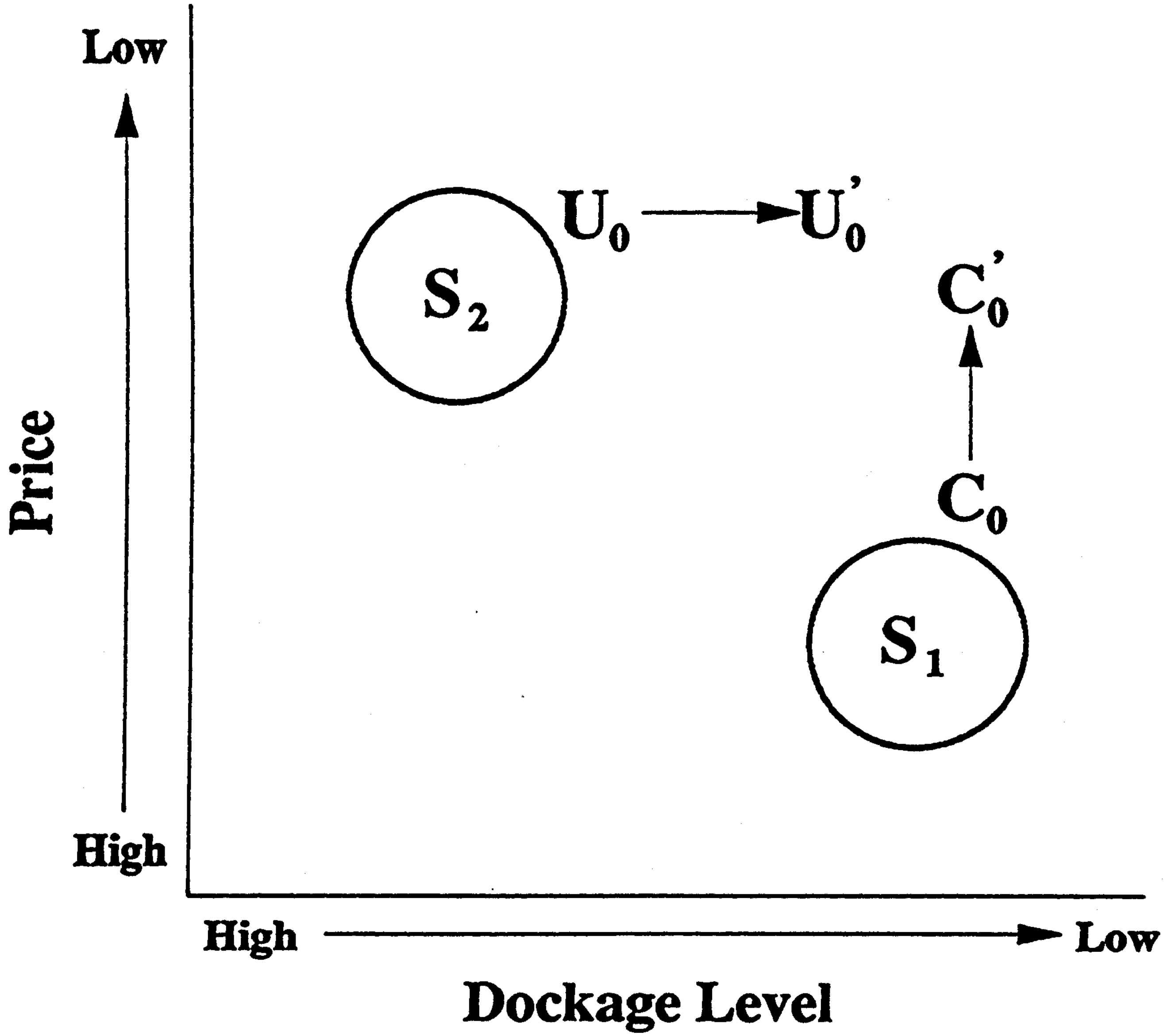

Figure 9 Competitive Positioning and Wheat Cleanliness

Aggregate Analysis of Benefits and Costs

This section provides aggregate estimates of costs and benefits of proposed policy changes for three classes of wheat: HRS, durum, and white. The methodology is described and results are discussed.

Changes in grain grade standards with respect to dockage will impact current handling and merchandising practices. The effects of any new regulation cannot be predicted with certainty, and alternative regulations would result in different distributions of benefits and costs. A number of policy approaches can be implemented to achieve the goal of cleaner wheat for export.

One proposal would incorporate dockage as a grade-determining factor in the grade standards for wheat. This proposal specifies U.S. grades #1, #2, and #3 with a maximum of 0.5% dockage and grades #4 and #5 with a dockage limit of 2.5%. Impetus for this proposal is that, since most importers specify U.S. #2 wheat, setting the dockage limit at 0.5% would ensure that most importers receive wheat with low levels of dockage.[14]

Aggregate benefits and costs of cleaning wheat to different dockage levels are derived for three cases. Under the Base Case, we calculate benefits and costs of cleaning wheat to an ending dockage level of 0.7%. This is close to current cleaning practices for country elevators in the durum and HRS wheat production region (where wheat is generally cleaned to an ending dockage level around 1%). An ending dockage level of 0.7% in the Base Case was chosen instead of 1% because the average dockage for both HRS and durum was 0.8% in 1990, and a Base Case with an ending dockage level of 0.7% can be compared more easily across two years for which we have appropriate data. We derived similar estimation using 1.0% as the Base Case; these are shown in Appendix A for reference. The Base Case is compared to two other cases in which wheat is restricted to be cleaned to lower levels.

In Case 1, wheat is restricted to be cleaned at the point of first sale. Thus, all spring wheat produced would be cleaned at country elevators to meet the specified dockage limit. In Case 1, like the Base Case, the entire production of wheat is cleaned at the country elevator. In Case 2, only wheat that is exported must meet the dockage limit. Wheat is either cleaned at the export elevator, or is bought cleaned, i.e., country elevators clean before shipment. In the Base Case and Case 1, the entire production is cleaned; in Case 2, only that which is exported is cleaned to these limits. By comparing results from the Base Case with those for the other two cases, we can derive the marginal benefits and costs to the marketing system of additional cleaning requirements implied in the proposed policy.

Benefits and costs of cleaning wheat in the three cases were derived from a modification of the optimization model developed in Johnson and Wilson. Specifically, the

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[14]While the majority of DNS is purchased in the international market as grade #2, this is less apparent in the case of durum. In this market, a significant proportion of durum sold from the United States is sold as #3. Of particular importance for the overall policy is that if some buyers shift from purchasing #2 (or #3) to the new lower grade, #4, at a reduced price, the more liberal allowances for other factors would reduce overall quality.

exporter's maximization problem is used, and restrictions are imposed on the model to correspond with the Base Case, Case 1, and Case 2. Costs involved with cleaning include machine cost (grain cleaner operating cost) and the value of wheat loss. Benefits include revenue from the sale of screenings and domestic transport savings (if the wheat is cleaned at the country elevator).[15]

A summary measure called a net cleaning cost is derived and reported on a per bushel basis. This is defined as

Net Cleaning Cost = cleaning cost (machine cost)
+ value of wheat loss
- transport savings
- sale of screenings

A complete description of machine and transport cost and the wheat loss factor are reported in Johnson and Wilson. The machine cost of removing a specific amount of dockage is not constant but depends on initial and ending dockage levels.

Costs and benefits of cleaning are impacted by the initial dockage level and the value of wheat and screenings, which vary from year to year and across wheat classes. For the sake of consistency with previous reports, simulations were conducted for two extreme years for durum and HRS wheat; 1987 had high dockage levels and low screening values, and 1990 had the opposite. Simulations for white wheat were conducted only for the 1990 crop year.

Table 10 contains values used in the simulations; dockage levels, screening values, and value of wheat at the country elevator are averages for that particular year. Value of exported wheat is the county elevator's value of wheat plus handling and transport costs. A handling cost of $7.34/MT represents the handling cost at both the country and export elevators. Transport costs were $36.66/MT and $12.66/MT for country elevators that handled durum and HRS and country elevators that handed white wheat, respectively. Transport costs are from the country to an export elevator, i.e., for spring wheat from central North Dakota to an export elevator located in the Pacific Northwest.

The actual amount of wheat cleaned varies among the three cases. In the Base Case and Case 1, the entire production is cleaned to a specific dockage level. In Case 2, only wheat exported is required to meet the proposed policy's dockage level. Production and export volumes are presented in Table 11 for HRS, durum, and white wheat. Total net cleaning costs for the three cases were derived by taking the net cleaning cost on a per bushel basis and multiplying by the appropriate volume of wheat.

The components of benefits and costs of cleaning and net cleaning costs for HRS and durum wheat for 1987 and 1990 are shown in Tables 12 and 13, respectively (Cases 1 and 2 cleaned to an ending dockage level of 0.5%).

[15] Other benefits associated with cleaning are increased storage capacity, increased aeration and drying efficiency, and reduced insect and mold problems. However, these benefits are not easily quantifiable and likely would be relatively inconsequential.

TABLE 10. PARAMETER VALUES USED TO DERIVE NET CLEANING COST

	Wheat				
	HRS		Durum		White
Item	1987	1990	1987	1990	1990
Dockage levels (%)	2.3[a]	0.8[a]	4.2[a]	0.8[a]	0.8[b]
Screenings ($/ton)	10[c]	30[c]	10[c]	30[c]	70[b]
Transport. ($/MT)	36.7	36.7	36.7	36.7	12.5
Wheat value ($/MT)					
Country elevator	91[c]	82[c]	126[c]	90[c]	80[d]
Export elevator	135	126	169	134	100

[a]Department of Cereal Science and Food Technology.
[b]Scherping et al.
[c]North Dakota State University.
[d]USDA/ERS.

TABLE 11. U.S. PRODUCTION AND EXPORT VOLUMES (MILLION BUSHELS)

	Wheat				
	HRS		Durum		White
Item	1987	1990	1987	1990	1990
Production	431	555	93	122	313
Exports	255	210	62	50	220

Source: USDA/ERS.

TABLE 12. BENEFITS AND COSTS OF CLEANING HRS AND DURUM WHEAT IN 1987 TO 0.7% (BASE CASE) AND ADDITIONAL BENEFITS AND COSTS OF CLEANING TO 0.5% (CASE 1) AND ONLY EXPORTED WHEAT TO 0.5% (CASE 2)

	Base Case		Case 1		Case 2	
Benefits and Costs	HRS	Durum	HRS	Durum	HRS	Durum
	----------- million dollars ------------					
Costs (-)						
Machine	15.5	4.6	2.2	0.6	1.3	0.4
Wheat loss	7.3	5.1	0.9	0.4	0.5	0.2
Benefits (+)						
Transport. savings	6.9	3.3	0.9	0.2	0.5	0.1
Sale of screenings	3.0	1.4	0.4	0.1	0.3	0.1
Net cleaning cost (costs - benefits)	12.9	5.0	1.7[a]	0.6[a]	1.0	0.4

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

TABLE 13. BENEFITS AND COSTS OF CLEANING HRS AND DURUM WHEAT IN 1990 TO 0.7% (BASE CASE) AND ADDITIONAL BENEFITS AND COSTS OF CLEANING TO 0.5% (CASE 1) AND ONLY EXPORTED WHEAT TO 0.5% (CASE 2)

Benefits and Costs	Base Case		Case 1		Case 2	
	HRS	Durum	HRS	Durum	HRS	Durum
	----------- million dollars ------------					
Costs (-)						
Machine	2.8	0.6	6.1	1.3	2.3	0.6
Wheat loss	0.6	0.1	1.1	0.2	0.4	0.1
Benefits (+)						
Transport. savings	0.6	0.1	1.1	0.2	0.4	0.1
Sale of screenings	0.6	0.1	1.7	0.4	0.6	0.2
Net cleaning cost (costs - benefits)	2.2	0.5	4.9[a]	1.1[a]	1.9[a]	0.4

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

Net cleaning costs for HRS and durum was $12.9 million and $5.0 million, respectively, in 1987 in the Base Case (Table 12). The additional net cost (marginal cost) of cleaning the entire production to an ending dockage level of 0.5% (Case 1) would be $1.7 million and $0.6 million for HRS and durum, respectively, in 1987 (Table 12). Thus, the net effect of a policy that requires wheat to be cleaned at point of first sale (Case 1) would be $14.6 million ($12.9 million + $1.7 million) and $5.6 million ($5.0 million + $0.6 million) for HRS and durum, respectively.

The additional net costs (marginal cost) in Case 2 are $1.0 million and $0.4 million for HRS and durum, respectively (Table 12). The additional net cleaning costs in Case 2 are less than those in Case 1 because volume of wheat to be cleaned is lower.

Net cleaning costs in the Base Case for 1990 (Table 13) are substantially less than those for 1987 (Table 12), even though production was greater in 1990. This resulted because the net cleaning costs on a per bushel basis were less in 1990 compared to 1987. Benefits and costs of cleaning were smaller in 1990 because less dockage was removed.

Tables 14 and 15 depict the three cases, except the ending dockage level in Cases 1 and 2 is 0.2% instead of 0.5%. This illustrates cleaning to an ending dockage level similar to competitor countries. The Base Case is the same as the previous two tables; however, the net cleaning costs in Cases 1 and 2 increase because the wheat is being cleaned to a lower dockage level.

One striking difference between Tables 14 and 15 concerns the machine cost of cleaning HRS wheat in Case 1. In 1987 (Table 14), machine costs were $5.2 million compared to $15.5 million in 1990 (Table 15). Initial dockage levels accounted for this differences. In 1990, the beginning dockage level for HRS was 0.8% compared to 4.2% in 1987; thus, machine costs in the Base Case were larger in 1987 than 1990. The marginal

TABLE 14. BENEFITS AND COSTS OF CLEANING HRS AND DURUM WHEAT IN 1987 TO 0.7% (BASE CASE) AND ADDITIONAL BENEFITS AND COSTS OF CLEANING TO 0.2% (CASE 1) AND ONLY EXPORTED WHEAT TO 0.2% (CASE 2)

Benefits and Costs	Base Case HRS	Base Case Durum	Case 1 HRS	Case 1 Durum	Case 2 HRS	Case 2 Durum
	million dollars					
Costs (-)						
Machine	15.5	4.6	5.2	2.0	3.1	1.4
Wheat loss	7.3	5.1	2.6	0.9	1.5	0.6
Benefits (+)						
Transport. savings	6.9	3.3	2.2	0.5	1.3	0.3
Sale of screenings	3.0	1.4	0.9	0.3	0.5	0.2
Net cleaning cost (costs - benefits)	12.9	5.0	4.7	2.2[a]	2.8	1.5

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

TABLE 15. BENEFITS AND COSTS OF CLEANING HRS AND DURUM WHEAT IN 1990 TO 0.7% (BASE CASE) AND ADDITIONAL BENEFITS AND COSTS OF CLEANING TO 0.2% (CASE 1) AND ONLY EXPORTED WHEAT TO 0.2% (CASE 2)

Benefits and Costs	Base Case HRS	Base Case Durum	Case 1 HRS	Case 1 Durum	Case 2 HRS	Case 2 Durum
	million dollars					
Costs (-)						
Machine	2.8	0.6	15.5	3.4	5.9	1.4
Wheat loss	0.6	0.1	2.8	0.6	1.0	0.2
Benefits (+)						
Transport. savings	0.6	0.1	2.8	0.6	1.0	0.2
Sale of screenings	0.6	0.1	3.3	0.7	1.3	0.3
Net cleaning cost (costs - benefits)	2.2	0.5	11.7[a]	2.6[a]	4.4[a]	1.0[a]

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

cost of cleaning from a dockage level of 0.7% (Base Case) to 0.2% (Case 1) was larger in 1990 than for 1987. However, the total machine cost is higher for 1987 than for 1990 when cleaning to an ending dockage level of 0.2% because more dockage is being removed in 1987. In Case 1, machine costs when cleaning to an ending dockage level of 0.2% were

$20.7 million ($15.5 million + $5.2 million) and $18.3 million ($2.8 million + $15.5 million) for 1987 and 1990, respectively.

Benefits and costs of cleaning white wheat and net cleaning costs are presented in Table 16. White wheat is grown in the Pacific Northwest, close to export facilities. In the simulations, it was optimal for wheat to be cleaned at the export elevator; thus, transportation savings were nil.

TABLE 16. BENEFITS AND COSTS OF CLEANING WHITE WHEAT IN 1990

Benefits and Costs	Base Case	Case 1	Case 2	Case 1	Case 2
	--- ending dockage level (%) ----				
	0.7	0.5	0.5	0.2	0.2
	------ million dollars ----------				
Costs (-)					
Machine	0.9	1.5	1.1	4.4	3.1
Wheat loss	0.6	1.6	1.1	3.8	2.6
Benefits (+)					
Transport. savings	0.0	0.0	0.0	0.0	0.0
Sale of screenings	1.2	2.5	1.8	6.0	4.2
Net cleaning cost (costs - benefits)	0.3	0.9[a]	0.7[a]	2.2	1.5

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

Net cleaning costs are low compared to durum and HRS wheat. The differences largely reflected by white wheat's higher screenings value. Screenings value for white wheat was $70/ton, which is relatively close to the wheat value. If screenings value were lowered, then net cleaning costs would increase.

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.[16]

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, screenings value, and transport cost. As these factors change, the implicit margin associated with cleaning changes, resulting in a change in the optimal quantity cleaned.

Johnson and Wilson provide a microeconomic model of wheat import decisions to determine the trade-off between prices 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 screenings 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, screening disposal costs, import duties, 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 nearly impossible.

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

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[16]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.

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 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 with greater specificity, it also potentially results is 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[17] 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 discussing the higher levels of dockage in U.S. shipments, foreign buyers concurrently describe the incidence of higher percentages of shrunken and broken kernels as well as other undesirable factors. These were confirmed in simple correlation analysis in this report. 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 implicilty 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.

[17]The term restrictive is used here to describe a configuration of factor limits that do not allow for transactions with marginally lower limits at lower prices. Thus, all lots are forced to be shipped at the same level.

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Appendix A

TABLE A.1. BENEFITS AND COSTS OF CLEANING HRS AND DURUM WHEAT IN 1987 TO 1.0% (BASE CASE) AND ADDITIONAL BENEFITS AND COSTS OF CLEANING TO 0.5% (CASE 1) AND ONLY EXPORTED WHEAT TO 0.5% (CASE 2)

Benefits and Costs	Base Case		Case 1		Case 2	
	HRS	Durum	HRS	Durum	HRS	Durum
	million dollars					
Costs (-)						
Machine	12.9	3.9	4.7	1.3	2.8	0.9
Wheat loss	6.0	4.6	2.2	0.8	1.3	0.6
Benefits (+)						
Transport. savings	5.6	3.0	2.2	0.5	1.3	0.3
Sale of screenings	2.6	1.3	0.9	0.2	0.5	0.1
Net cleaning cost (costs - benefits)	10.8[a]	4.2	3.9[a]	1.5[a]	2.3	1.0[a]

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

TABLE A.2. BENEFITS AND COSTS OF CLEANING HRS AND DURUM WHEAT IN 1990 FROM PRODUCTION DOCKAGE LEVEL (BASE CASE) AND ADDITIONAL BENEFITS AND COSTS OF CLEANING TO 0.5% (CASE 1) AND ONLY EXPORTED WHEAT TO 0.5% (CASE 2)

Benefits and Costs	Base Case[a]		Case 1		Case 2	
	HRS	Durum	HRS	Durum	HRS	Durum
	million dollars					
Costs (-)						
Machine	0.0	0.0	8.9	2.0	3.4	0.8
Wheat loss	0.0	0.0	1.7	0.4	0.6	0.2
Benefits (+)						
Transport. savings	0.0	0.0	1.7	0.4	0.6	0.2
Sale of screenings	0.0	0.0	2.2	0.5	0.8	0.2
Net cleaning cost (costs - benefits)	0.0	0.0	7.2[b]	1.6[b]	2.7[b]	0.6

[a]Base Case benefits and costs are not present since the average beginning dockage level for both HRS and durum was 0.8%.
[b]Numbers do not add up because of rounding.

TABLE A.3. BENEFITS AND COSTS OF CLEANING HRS AND DURUM WHEAT IN 1987 TO 1.0% (BASE CASE) AND ADDITIONAL BENEFITS AND COST OF CLEANING TO 0.2% (CASE 1) AND ONLY EXPORTED WHEAT TO 0.2% (CASE 2)

	Base Case		Case 1		Case 2	
Benefits and Costs	HRS	Durum	HRS	Durum	HRS	Durum
	million dollars					
Costs (-)						
Machine	12.9	3.9	7.8	2.7	4.6	1.8
Wheat loss	6.0	4.6	3.9	1.4	2.3	0.9
Benefits (+)						
Transport. savings	5.6	3.0	3.4	0.7	2.0	0.5
Sale of screenings	2.6	1.3	1.3	0.4	0.8	0.2
Net cleaning cost (costs - benefits)	10.8	4.2	6.9[a]	3.1[a]	4.1	2.0

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

TABLE A.4. BENEFITS AND COSTS OF CLEANING HRS AND DURUM WHEAT IN 1990 FROM PRODUCTION DOCKAGE LEVELS (BASE CASE) AND ADDITIONAL BENEFITS AND COSTS OF CLEANING TO 0.2% (CASE 1) AND ONLY EXPORTED WHEAT TO 0.2% (CASE 2)

	Base Case[a]		Case 1		Case 2	
Benefits and Costs	HRS	Durum	HRS	Durum	HRS	Durum
	million dollars					
Costs (-)						
Machine	0.0	0.0	18.3	4.0	6.9	1.6
Wheat loss	0.0	0.0	3.3	0.7	1.3	0.3
Benefits (+)						
Transport. savings	0.0	0.0	3.3	0.7	1.3	0.3
Sale of screenings	0.0	0.0	3.9	0.8	1.5	0.4
Net cleaning cost (costs - benefits)	0.0	0.0	13.9*b*	3.0[b]	5.2[b]	1.2

[a]Base Case benefits and costs are not present since the average beginning dockage level for both HRS and durum was 0.8%.
[b]Numbers do not add up because of rounding.

TABLE A.5. BENEFITS AND COSTS OF CLEANING WHITE WHEAT IN 1990

Benefits and Costs	Base Case	Case 1	Case 2	Case 1	Case 2
	---- ending dockage level (%) ----				
	0.7	0.5	0.5	0.2	0.2
	-------- million dollars ---------				
Costs (-)					
Machine	0.0	2.5	1.8	5.3	3.7
Wheat loss	0.0	2.2	1.5	4.4	3.1
Benefits (+)					
Transport. savings	0.0	0.0	0.0	0.0	0.0
Sale of screenings	0.0	3.8	2.6	7.2	5.1
Net cleaning cost (costs - benefits)	0.0	1.2[b]	0.9[b]	2.5	1.8[b]

[a]Base Case benefits and costs are not present since the average beginning dockage level was 0.8%.
[b]Numbers do not add up because of rounding.