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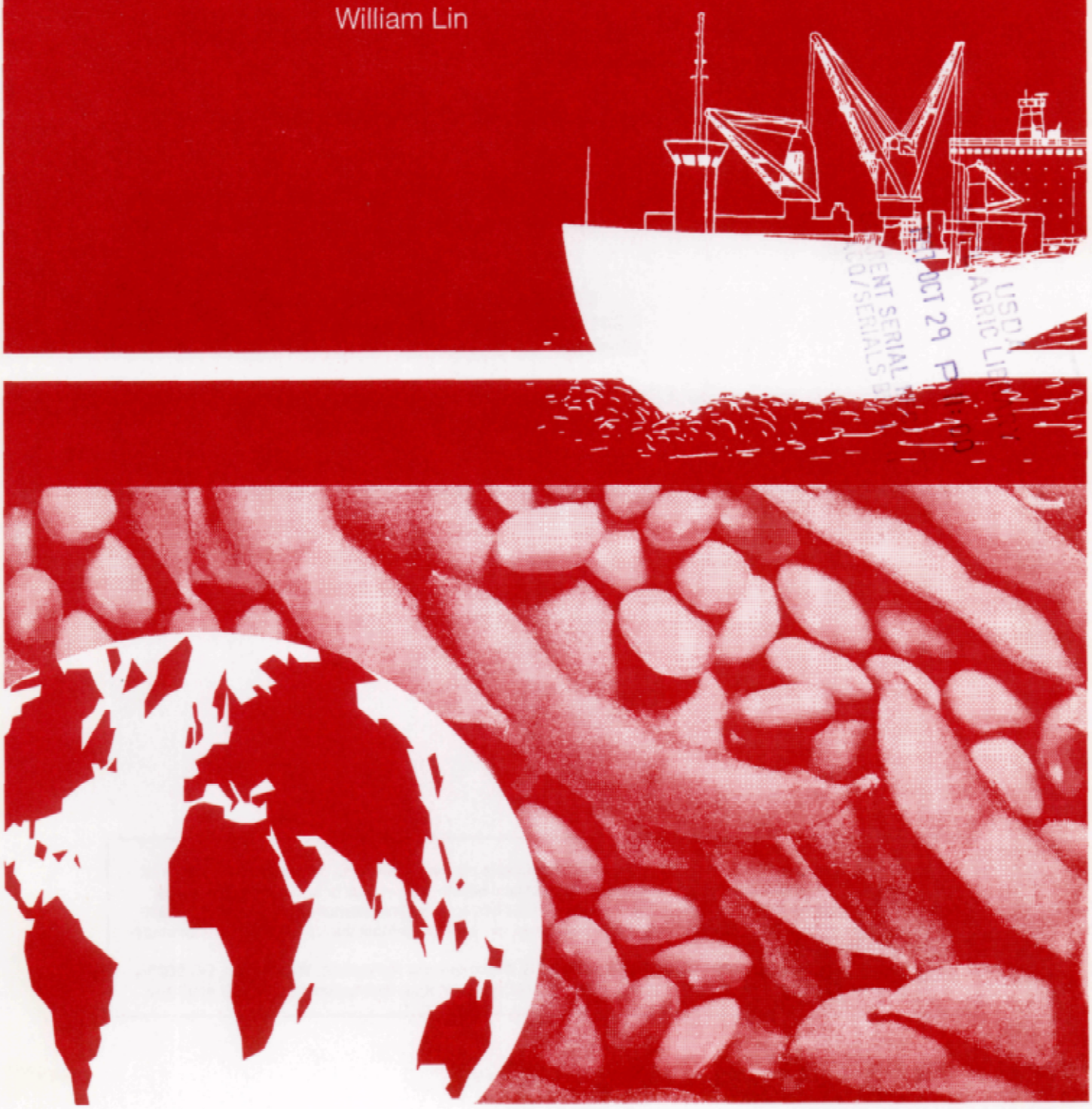
An Economic Research Service Report

Costs and Benefits of Cleaning U.S. Soybeans

Overview and Implications

William Lin



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Costs and Benefits of Cleaning U.S. Soybeans: Overview and Implications.
By William Lin. Commercial Agriculture Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report No. 736.

Abstract

Cleaning is not the solution to the soybean cleanliness issue. The costs of additional cleaning of all export soybeans to remove foreign material (FM) beyond the current level would, at minimum, exceed the domestic and international benefits by $20 million per year even if cleaning occurs at the least net-cost locations—river elevators and inland subterminals. Producers and handlers in the South would bear a disproportionate share of the net costs because of higher soybean FM level and larger export share of soybean production than the Corn Belt. Lowering soybean FM by altering production and harvesting practices offers an alternative to mechanical cleaning (a small percentage of producers can do so at little additional cash cost), but its cost-effectiveness needs to be evaluated more fully before adoption. Despite foreign buyers' preference for clean soybeans, foreign material is regarded as less critical than protein, oil, and moisture contents.

Keywords: Soybeans, foreign material (FM), cleaning, quality, costs, benefits, policy options

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August 1996

Foreword

In recent years there have been increasing concerns over the quality of grains exported from the United States versus the quality of competitors' grain. Some observers believe that selling grain that contains higher levels of broken kernels, foreign material, and dockage than that of our competitors has reduced U.S. competitiveness in the world grain market. Advocates argue that improving the cleanliness of U.S. grain will increase market share or is necessary to maintain U.S. market share. Critics argue that improving the overall cleanliness of U.S. grain will increase marketing costs, reduce profits, and diminish U.S. competitiveness.

Congress recognized that available information was insufficient to support either claim. Therefore, the Food, Agriculture, Conservation, and Trade Act of 1990 mandated that the then Federal Grain Inspection Service (FGIS), now part of the Grain Inspection, Packers and Stockyards Administration (GIPSA), determine the costs and benefits associated with cleaning U.S. grain. Title XX of the act, entitled "Grain Quality Incentives Act of 1990," called for a comprehensive commodity-by-commodity study of economic costs and benefits of cleaning grain. In response, FGIS signed a cooperative research agreement with ERS in September 1990 to conduct an economic study of the costs and benefits of cleaning U.S. grains. The agreement specified that the project cover five commodities: wheat, corn, soybeans, sorghum, and barley.

This report presents an overview and implications of the study results for soybeans. ERS's soybean study produced two additional reports. The first, *Economic Implications of Cleaning Soybeans in the United States*, focuses on the costs and domestic benefits of cleaning soybeans. The second, *The Role of Quality in Soybean Import Decisionmaking*, focuses on importers' preferences with respect to cleanliness and other quality factors, and assesses international benefits from cleaning export soybeans. The first report is based primarily on special studies conducted by contractors representing trade associations and State agricultural experiment stations. The second report is based on a series of case studies on the soybean and oilseed markets and import decisionmaking in 11 countries. Reports for wheat, corn, and sorghum have been completed, and the report for barley is forthcoming.

ERS received valuable input and advice from a steering committee comprised of representatives of many industry associations and commodity organizations. The authors of reports prepared under research agreements with ERS also made important contributions. As with all ERS studies, however, the content of this report is the sole responsibility of ERS.

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Summary

Some foreign buyers prefer cleaner U.S. soybeans, but the costs of additional cleaning would exceed the domestic and international benefits by at least $20 million per year. This report summarizes two other reports produced by USDA's Economic Research Service. The reports suggest that the U.S. soybean export market can potentially benefit more by improving the protein and oil contents of the soybeans because most importers are unwilling to pay more for cleaner beans.

The other two reports in the series are:

Economic Implications of Cleaning Soybeans in the United States, which focuses on the costs and domestic benefits of cleaning soybeans.

The Role of Quality in Soybean Import Decisionmaking, which emphasizes importers' preferences with respect to cleanliness and other quality factors, and assesses the benefits of cleaning soybeans for international markets.

According to the reports, the costs of additional cleaning to lower the level of foreign material in soybeans would exceed the domestic and international benefits by $20 million to $70 million per year, although a figure near the lower end of the range is believed to be more likely. (Foreign material includes plant parts, broken beans, weed seeds, dirt, whole beans, pods, insects, and corn.)

Concern over the quality of soybeans exported by the United States in comparison with competitors' soybeans has increased in recent years. Advocates of tighter cleanliness standards believe that U.S. competitiveness in the soybean market has been reduced due to higher foreign material levels in exported soybeans. In contrast, critics of tighter standards argue that improving cleanliness will increase marketing costs, reduce profits, and therefore diminish U.S. competitiveness.

This report has been prepared in response to a request from Congress. ERS conducted the study on the costs and benefits of cleaning soybeans in cooperation with researchers at land-grant universities and the soybean industry. This report is the third in a series which began with wheat and corn.

Selling cleaner soybeans seems to have limited effects in increasing export revenues and in improving U.S. competitiveness in the world soybean market. The possible benefits of cleaner soybeans are a premium of $4-$5 million that foreign buyers would be willing to pay for U.S. soybeans with less foreign material and $2 million additional net gains in terms of potential retention of U.S. market share in a few Asian markets where food use accounts for a large share of soybean imports. The presence of foreign material in soybeans destined for food use can contaminate the end-products and reduce milling yield, and is often associated with low protein content.

For most importers, price was regarded as the most important factor in purchasing decisions. Quality ranks second to price in import decisionmaking, particularly among feed-use buyers, although the two factors are closely related

through the crushing margin. Soybean processors in only a few countries indicated a willingness to pay more for cleaner beans, although cleanliness is one of the most important quality characteristics they look for after protein content, oil content, and moisture.

Brazilian soybeans are perceived by foreign buyers to be lower in price, cleaner, and of higher quality both in protein and oil contents than U.S. soybeans. However, some buyers avoid soybeans from both Brazil and Argentina because of a darker soyoil color and a reddish soymeal tint. Others choose to import U.S. soybeans because of the U.S. ability to supply soybeans year-round and reliability of timely supply—two desirable sourcing factors lacking in competitors' soybeans.

Marketing cleaner soybeans requires more incentives than currently exist in the U.S. marketplace. In addition to mechanical cleaning, the amount of foreign material can be lowered by such production and harvesting practices as drilled planting, herbicide use, and combine adjustment.

Beyond cleanliness, U.S. policy options in regard to improving soybean marketability include changing grades and standards, improving oil and protein yields through plant breeding and genetic research, mandatory testing and reporting of protein and oil contents, and launching an information program to enhance U.S. quality competitiveness.

Costs and Benefits of Cleaning U.S. Soybeans

Overview and Implications

William Lin

Introduction

In recent years, there have been concerns over the quality of U.S. grain exports versus the quality of competitors' grain. Foreign buyers have complained that foreign material (FM) levels in U.S. soybeans are higher than competitors' beans. Do the higher levels of FM hamper U.S. competitiveness in the soybean world market? If the answer to this question is yes, are benefits from additional cleaning enough to compensate for the costs? Are policy options available that would mitigate or eliminate these problems? (See box describing concerns about soybean cleaning.)

In response to these questions, Congress included a Grain Quality Title (XX) in the Food, Agriculture, Conservation, and Trade Act of 1990. The Title required the U.S. Department of Agriculture (USDA) to conduct a comprehensive study of the costs and benefits associated with additional cleaning prior to making changes in cleanliness standards. Earlier, Congress had also directed the Office of Technology Assessment to conduct a comprehensive study of technologies, institutions, and policies that affect U.S. grain quality and to prepare a comparative analysis of the grain systems of major exporters.[1]

[1]The results of this study were published in three reports titled: (1) *Enhancing the Quality of U.S. Grain for International Trade*, OTA-F-399; (2) *Enhancing the Quality of U.S. Grain for International Trade: Summary*, OTA-F-400; and (3) *Grain Quality in International Trade: A Comparison of Major U.S. Competitors*, OTA-F-402 (Washington, DC: U.S. Government Printing Office, February 1989).

Concerns Over Soybean Cleaning

The issues being debated that relate to soybean cleanliness include:

- Members of Congress and soybean producers are concerned that U.S. competitiveness in the world market may be hampered by higher levels of FM, as well as lower protein and oil contents in U.S. export soybeans compared with soybeans exported by major competitors.

- The U.S. soybean industry is concerned that any policy changes that require additional cleaning of soybeans would force producers or elevator operators to incur higher costs. These higher costs might not be recovered in the marketplace, and this could put the U.S. soybean industry at a competitive disadvantage.

- Foreign buyers specifying U.S. No. 2 (the base grade–the grade most commonly traded) have sometimes complained of receiving U.S. soybeans with FM levels that exceed the 2-percent limit. These buyers often found FM in U.S. soybeans about 1 percentage point higher than competitors' beans.

The mandated grain cleaning study stems from a lack of conclusive evidence on the effect of additional cleaning on U.S. competitiveness and associated costs and benefits. Some observers believe that selling grain with higher levels of dockage, broken kernels, and FM than that of our competitors has reduced U.S. competitiveness in the world grain market. Advocates of tighter U.S. grain cleanliness standards argue that improving grain cleanliness either will increase U.S. share in the world market or is necessary to maintain U.S. market share at current levels. On the other hand, many traders and handlers argue that tighter grain cleanliness standards will increase marketing costs, reduce profits, and diminish U.S. price competitiveness.

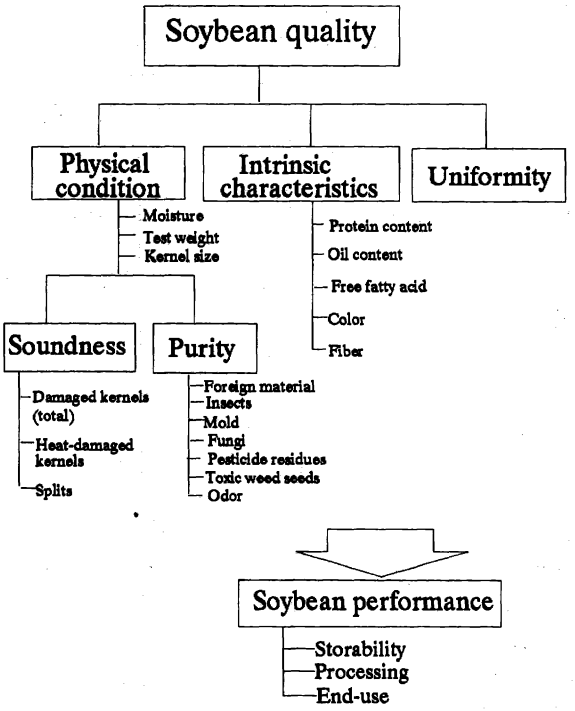
Defining Cleanliness in Soybean Quality

For the purposes of this study, soybean cleanliness refers to the measured level of FM present in soybeans. FM is defined as all material, such as pieces of soybeans, weed seeds, plant parts, other grains, leaves, dirt, stone, and stalks, that passes through an 8/64-inch, round-hole sieve and all nonsoybean material that remains in the sample after sieving. Cleaning soybeans with typical equipment would remove some proportion of the FM and, to a lesser degree, split soybeans.

Soybean FM primarily consists of plant parts, broken soybeans, and weed seeds. According to a producer survey conducted by the American Soybean Association, which consisted of 1,677 samples across 29 States, the composition of soybean FM for the 1991 crop at harvest was: plant parts, 37.5 percent; broken soybeans, 24.2 percent; weed seeds, 23.5 percent; dirt, 9.6 percent; whole soybeans, 2.4 percent; pods, 2.3 percent; insects, 0.6 percent; and corn, 0.1 percent (Hurburgh, Lang, and Buresh).[2]

Soybean quality, a much broader concept than cleanliness, has three dimensions: (1) physical condition, including purity and soundness; (2) intrinsic characteristics; and (3) uniformity (fig. 1). Soundness factors, including total damaged kernels, heat-damaged kernels, and splits, relate to physical defects and damage. Purity measures the quantity of nonsoybean material and wholesomeness factors present in a soybean lot. Other physical characteristics, not included

Figure 1
Soybean quality dimensions that affect end-use performance



Source: Adapted from the ERS domestic corn cleaning study.

in the soundness and purity subcategories, are moisture, test weight, and kernel size. Intrinsic characteristics are the structural and biological attributes inherent in soybeans, such as protein content, oil content, and free fatty acid (FFA) in soybeans. Uniformity measures the degree of variation in the physical and intrinsic characteristics both within and between shipments. The soundness, purity, and intrinsic characteristics of soybeans all affect its performance in terms of storability, processing, and end-use properties.

The importance of each soybean quality characteristic differs depending on the end-use of soybeans. Soybean crushers, accounting for the use of nearly 70 percent of U.S. soybeans sold by producers, are concerned with protein and oil contents as well as FM in soybeans because of the needs of producing high-quality soybean oil and soybean meal that meet protein requirements. The edible soybean processors are also concerned with protein content, FM, and splits, and may require tighter standards for FM, splits, and damaged kernels.

U.S. grades and standards for soybeans address cleanliness through the inclusion of FM as a grade-deter-

[2]Names in parentheses refer to sources listed in the References at the end of this report.

mining factor. The maximum limit for FM in grade U.S. No. 1 (the base grade traded in domestic markets) is 1 percent. The predominant export grade is U.S. No. 2 and its maximum limit for FM is 2 percent.[3] U.S. No. 2 is normally priced lower than U.S. No. 1 to reflect the lower value associated with higher limits for heat-damaged kernels, total damaged kernels, splits, and FM allowed in the standards.

Soybean Cleanliness in the United States

Most soybean FM originates from the farm. The level of FM at harvest averages 1.3 percent, according to an on-farm survey conducted by grain grower associations in 1991. FM in soybeans grown in the Midwest generally is lower than those grown in the South because of more chemical applications, higher soybean yields, and better canopy. According to the new crop quality survey conducted by the Grain Inspection, Packers and Stockyards Administration (formerly the Federal Grain Inspection Service (FGIS)), while the FM level in soybeans averaged 1.8 percent and 1.3 percent, respectively, for the western Corn Belt and eastern Corn Belt during 1987-90, the FM level averaged 3.1 percent and 3.0 percent for the Midsouth and Southeast (Hurburgh, 1994).

Despite breakage of kernels during handling, the amount of FM removed as it moves through marketing channels largely offsets the amount of breakage that occurs. As soybeans move through the marketing system, the proportion of broken soybeans increases due to breakage during handling and the proportion of nonsoybean materials decreases due to additional cleaning and the restrictions against re-adding FM into soybeans, once removed.

The FM level in U.S. soybeans increases as soybeans move from the farm gate to country elevators, river elevators or inland subterminals, and port elevators. The FM level increases to 1.5 percent when soybeans are delivered to country elevators. A typical lot of U.S. soybeans for export would move from country elevators to subterminals, and then to export elevators. The FM level averages 1.5 percent when it arrives at subterminal elevators, and 1.8 percent by the time soybeans arrive at export elevators. During 1990-94, the FM level of U.S. soybean exports averaged 1.7 percent, as reported on U.S. inspection certificates at loading. This FM level would decline to about 1.0 percent if additional cleaning to remove 0.5 percentage point of FM occurred at subterminal elevators—the least net-cost locations (Lin).

Most analysts believe that the percentage of producers who own cleaners that can be used to clean soybeans does not exceed 20 percent. Soybean cleaning is more common in the South than in the Midwest largely because of higher FM content in soybeans harvested in the South. Similarly, the commercial elevator survey conducted by the National Grain and Feed Association (NGFA) showed that 77 percent of all commercial elevators in the South cleaned soybeans received, compared with 32 percent in the Midwest. Nationally, 22 percent of the responding country elevators cleaned soybeans. These elevators cleaned an average of 53 percent of soybeans handled and removed an average of 1.3-percent FM.

Costs of Cleaning U.S. Soybeans

This study measures the costs and benefits of cleaning U.S. soybeans to lower the FM content of export soybeans from the current level to the targeted 1 percent under two scenarios: (1) lower bound cost, and (2) upper bound cost. The lower bound cost scenario is based on FM frequency distribution data at each market point of the production-marketing system and assumes cleaning applies only to high-FM soybeans selectively. The upper bound cost scenario is based on the average FM in soybeans and thus assumes that each bushel of soybeans produced or handled requires additional cleaning.

Five cases that would allow the attainment of cleaner U.S. soybeans under each of the two scenarios were evaluated: (1) clean all soybeans marketed by producers on the farm, (2) clean all soybeans received at country elevators, (3) clean a quantity equivalent to total exports at country elevators, (4) clean all soybeans received at both river elevators and inland subterminals, and (5) clean all export soybeans at export elevators.

Case 1 assumes that additional cleaning applies to all soybeans marketed by producers because they cannot differentiate between soybeans destined for domestic sales and soybeans destined for export markets. Cases 2 and 3 illustrate the range of economic outcomes that are associated with cleaning options rang-

[3]About 92 percent of U.S. soybeans exported during 1992-94 were No. 2.

ing from cleaning only export soybeans to cleaning all soybeans handled by country elevators. Case 2, the most realistic option, reflects the fact that most country elevators do not have perfect knowledge about the destination of their soybean shipments. Thus, additional cleaning of export soybeans may require additional cleaning of the total volume handled by country elevators. In contrast, case 3, an optimal situation that is less likely to occur, assumes that country elevators (especially those owned by large cooperatives or multi-national grain traders) have perfect knowledge about the destination of their soybean shipments so that additional cleaning can be applied only to outbound soybean shipments for export, not to the entire volume handled. Cases 4 and 5 represent options for cleaning soybeans during the final stages of the production-marketing system.

Estimated total costs of delivering cleaner soybeans on the farm ranged from $74 million on a yearly basis through combine adjustment to $135 million under the lower bound cost scenario and $382 million under the upper bound cost scenario for mechanical cleaning (tables 1 and 2). Under the lower bound scenario, the costs are estimated to reach $106 million at country elevators if cleaning applies to all soybeans received, $40 million combined at both river elevators and inland subterminals, and $131 million at export elevators (table 1). The lower bound cost estimates are based on soybean FM frequency distribution data to determine additional cleaning needed to meet a reduced FM target of 0.5 percent at the farm, and 1 percent at interior and export elevators. The lower limit for on-farm cleaning, given the increase in FM as soybeans move through the production-marketing system, would make the grade limit of FM for U.S. export soybeans comparable with Brazilian soybeans. The estimates of the upper bound cost scenario are based on the average FM at various market points:

Market point	Initial FM	Targeted FM
	Percent	
Farm	1.0	0.5
Interior elevator	1.5	1.0
Export elevator	2.0	1.0

The 1.0-percent FM content at export inspection is a cleanliness level commonly specified by cleanliness-

Table 1—Annual costs and domestic benefits of additional soybean cleaning: lower bound cost scenario[1]

Point of cleaning	Volume cleaned	Costs	Benefits	Net costs
	Million bushels	----------*Aggregate (million dollars)*----------		
Farms:				
Mechanical	1,353	135.1	28.2	106.9
Combine	2,041	73.5	10.2	63.3
Country elevators:				
Volume handled	1,276	105.6	35.0	70.6
Volume exported	428	35.2	10.7	24.5
River elevators and inland subterminals	428	39.9	13.5	26.4
Export elevators	654	130.9	33.2	97.7
		Cents per bushel cleaned		
Farms:				
Mechanical		10.0	2.1	7.9
Combine		3.6	0.5	3.1
Country elevators:				
Volume handled		8.3	2.7	5.5
Volume exported		8.2	2.5	5.7
River elevators and inland subterminals		9.3	3.2	6.2
Export elevators		20.0	5.1	14.9

[1]Additional cleaning applies only to high-FM soybeans selectively based on FM frequency distribution data at each market point.

Source: Adapted from Hurburgh (1994).

Table 2—Annual costs and domestic benefits of additional soybean cleaning: upper bound cost scenario[1]

Point of cleaning	Volume cleaned	Costs	Benefits	Net costs
	Million bushels	----------*Aggregate (million dollars)*----------		
Farms:				
Mechanical	2,041	381.7	36.8	344.9
Combine	2,041	73.5	10.2	63.3
Country elevators:				
Volume handled	2,041	242.8	58.3	184.5
Volume exported	684	81.3	18.5	62.8
River elevators and inland subterminals	684	99.2	23.0	76.2
Export elevators	684	143.7	34.7	109.0
		Cents per bushel cleaned		
Farms:				
Mechanical		18.7	1.8	16.9
Combine		3.6	0.5	3.1
Country elevators:				
Volume handled		11.9	2.9	9.0
Volume exported		11.9	2.7	9.2
River elevators and inland subterminals		14.5	3.4	11.1
Export elevators		21.0	5.1	15.9

[1]Additional cleaning involves the removal of FM from an initial level of 1.0 percent to 0.5 percent target at the farm, from 1.5 to 1.0 percent target at country and river/inland subterminal elevators, and from 2.0 percent to a 1.0-percent target at export elevators.

Source: Adapted from Hurburgh (1994).

conscious foreign buyers (after allowing for an additional 0.3-percentage-point breakage during loading at export elevators), and it is comparable with the grade limit for "clean" soybeans exported by competitors.

Weight loss, the loss of revenues resulting from not being able to sell screenings (including FM and non-FM components) at the soybean price, was a major cost component of cleaning soybeans, accounting for two-thirds at the farm to about three-quarters at interior elevators, and over 90 percent at export elevators.[4] In physical quantity, screenings removed on average account for 2.8 percent of soybeans cleaned at the farm, 1.8 percent at country elevators, 2.2 percent at river elevators and inland subterminals, and 3.1 percent at export elevators (Hurburgh, 1994).

Under the lower bound scenario, only a portion of screenings removed is counted as weight loss because FM greater than 1 percent is commonly deducted from the gross weight by the buyer before payment is made to the seller. Thus, no additional loss of revenues would occur if screenings (as a result of additional cleaning) were removed from soybeans with FM of greater than 1 percent. In contrast, all screenings removed are counted as weight loss under the upper bound scenario where (1) commercial elevators are assumed unable to clean soybeans on a selective basis, particularly for high-volume operations in river and export elevators, and (2) weight deductions are assumed to be recaptured later through blending.

Soybean cleaning costs, as addressed in this section, were easier to identify and estimate than the potential premium and trade benefits reported in the next section. The cost estimates were based on the economic-engineering studies—an approach that assesses the cost-output relationship for a production process by separating the production activities into stages and then estimating the input-output relationships at each stage of the production operation.[5] Marginal cleaning

[4]In comparison, weight loss in cleaning corn was estimated to be 55-70 percent of the total costs of cleaning. The lower value of weight loss in corn cleaning reflects lower per bushel prices for corn relative to soybeans.

[5]These studies were conducted by a group of agricultural engineers at the Iowa State University.

costs might potentially decline over time as cleaning technologies become more efficient. In contrast, the estimates of benefits from premiums for cleaner soybeans and increased trade volumes were largely derived from interviews with foreign buyers. The estimates reflect how they report they would react if the United States exported cleaner soybeans and thus is highly subjective.

Producer Practices

Since weed seeds are an important part of soybean FM, altering production practices offers a real potential of lowering FM in soybeans. According to an on-farm survey conducted by the University of Illinois, 69 percent of respondents indicated that they can reduce the level of FM in soybeans by changing production practices.

More cultivation and tillage of soil can reduce weed problems and reduce herbicide input required for weed control. However, these changes involve additional expenses and need to be evaluated for their cost-effectiveness. Also, these changes can contribute to other problems, such as soil erosion. Inclement weather can also thwart its effectiveness. In addition, concerns over sustainability of agriculture have led to an increasing adoption of reduced tillage practices (including no-tillage and various forms of conservation tillage).

Use of herbicide to better control weeds remains one of the most effective means of reducing the FM level of soybeans, but also involves some costs. Chemicals are already applied to virtually all soybeans in the United States and with increasing adoption of no-till, narrow row soybeans, modification of herbicide use may be necessary. The viability of increasing chemical applications to reduce FM in soybeans, however, is and will continue to be controversial because of public concerns over water pollution and chemical residues on food.

Drilled planting is another effective means of controlling weed seeds. Where weed seeds are a problem, producers need to re-evaluate weed control methods. The answer may not be more tillage or more herbicides; instead, weeds can be controlled by drilled planting. Weeds are usually less competitive in drilled beans than rowed beans, since they shade the soil much more quickly in narrower rows. In conjunction with the increasing use of reduced tillage, drilled soybean planting potentially could gain popularity in the future.

Certain crop rotations can be used to interrupt the life cycle for some pests and reduce the incidence of weed, insect pests, and diseases. Crop rotation effectively reduces chemical costs and raises crop yields. The most common practice is a corn-soybean rotation because of its high profitability, partly due to the nitrogen contribution of soybeans relative to other rotations, as well as reduction in weed, insect pests, and diseases (Sundquist, Menz, and Neumeyer). Because this practice is already in wide use—accounting for 43 percent of total cropping practices in 1992 based on the cropping practice survey conducted by the National Agricultural Statistics Service (NASS) and Economic Research Service (ERS), the potential for additional adoption of this practice to control weed seeds and other problems is limited.

Producers can also alter harvesting and handling practices to lower FM and to reduce breakage. Thirty-two percent of soybean producers responding to the on-farm survey indicated they were already delivering less than 0.5-percent FM in soybeans. An additional 11 percent currently delivering more than 0.5-percent FM could deliver 0.5-percent or less FM at little additional cash cost by changing harvesting and handling practices. However, changing harvesting and handling practices may involve some costs as a result of adjusting labor or equipment usage. Also, increased harvest time may be required, which involves additional costs. Overall, two-thirds of the on-farm survey respondents indicated that they could alter harvesting and handling practices to reduce the FM level.

Combine adjustment is the most common method of altering harvesting practices to lower the FM level. A modern, properly adjusted combine will remove nearly all of the stem and pod pieces at harvest. However, there are costs associated with such adjustments. Modifications to improve grain separation may delay harvest schedule and result in higher seedcoat damage or loss of grain. Setting it improperly so as to cut soybeans below the lowest pod could inadvertently introduce dirt into the harvested soybeans. To avoid this potential problem, header height must be properly set to operate near or at ground level.

The moisture content at harvest affects the amount of kernel damage produced through combining.

Harvesting soybeans at a moisture content around 13-15 percent generally results in less breakage than harvesting at higher moisture because the pericarp is not as easily damaged. As soybeans dry down for the first time, harvest is generally delayed until the moisture content reaches 13.5 percent. However, when under time pressure to complete harvest as quickly as possible, farmers may harvest at higher moisture. Harvested soybeans are dried in a bin, and if dried too fast, could result in stress cracks leading to further breakage in handling. Increased field losses occur when soybeans are harvested at moisture levels below 12 percent (Paulsen). Breakage of soybeans is more a function of the moisture content at harvest than it is driven by differences in genotypes or varieties (Paulsen).

Country and Subterminal Elevators

The costs of additional soybean cleaning at country elevators to achieve a reduction in FM from the current level to the 1.0-percent target, under the lower bound scenario, are estimated to average 8.3 cents per bushel. Weight loss is the highest cost component of additional cleaning, accounting for 70 percent of total cleaning costs. The total cost of cleaning all soybeans received at country elevators is estimated to be $106 million per year; however, the cost would be lower if country elevators had some knowledge of the ultimate destination of soybean shipments. The cost of cleaning a volume equivalent to annual exports is estimated to be $35 million.

Country elevators purchase most of the soybeans they handle from producers and sell to terminal elevators, domestic processors, and export elevators. They generally do not offer premiums for clean soybeans; however, price discounts are frequently used to discourage the delivery of soybeans with a FM content higher than the 1-percent limit for U.S. No. 1. Country elevators avoid discounts for FM on their sales by mechanically cleaning or blending lots with different FM contents. The choice depends on market incentives, costs of cleaning, market prices for screenings, and transportation costs. Blending lots of high- and low-FM soybeans to meet the grade requirements is common.

About 22 percent of country elevators handling soybeans nationwide cleaned soybeans as part of normal operation. However, soybean cleaning is more common in the South where FM is higher. Over 50 percent of the responding elevators in the Southeast and Delta States cleaned soybeans, more than double the nationwide average. Country elevators cleaned an average of 53 percent of beans handled, and removed 1.3 percent of the volume as FM.

River elevators and inland subterminals are the least net-cost point of cleaning U.S. export soybeans beyond the current level because they have a smaller cleaning volume than farms or country elevators, and their value of weight loss is much smaller than at export elevators. The value of weight loss is smaller because the physical quantity of screenings removed is smaller and soybean prices are lower as well at river elevators and inland subterminals. Under the lower bound scenario, the net cost of cleaning averages 6.2 cents per bushel of soybeans cleaned at both of these types of subterminals. In contrast, per-bushel net cost would be as high as 14.9 cents if cleaning occurred at export elevators. The total domestic net cost of cleaning export soybeans at both river elevators and inland subterminals is $26 million per year. This estimate assumes that the total volume of soybeans received at the subterminals is destined for export markets.

The segregation of cleaned soybeans at country and subterminal elevators for shipments to export elevators would reduce operating efficiency to some extent and increase costs further—a cost not included in benefit-cost calculations of this study.[6] Segregating clean soybeans may not be practical for elevators that have limited storage space for two reasons: (1) quick assembly of soybeans from producers is required at harvest time, and (2) segregation based on other quality factors (such as moisture or oil content) could offer greater profit potential in blending operations. In addition, cleaning during loading, which is more common at terminal elevators, would require more cleaning capacity. Cleaning during unloading, which is more common at country elevators, is more practical after the peak harvest time.

Export Elevators

To remove an additional 1 percentage point of FM at export elevators could cost an average of 20 cents per bushel under the lower bound scenario, higher than

[6]Shipments of soybeans from farms to export ports directly account for only a very small fraction of total shipments.

cost estimates for country and subterminal elevators. Per-bushel costs of cleaning at this point are the highest because of greater value of weight loss and higher costs of transporting screenings back to feeders and livestock feeding areas, or to soybean processing facilities for reblending into low-protein soybean meal. The aggregate cost of additional cleaning for all export soybeans at export elevators is estimated to be $131 million, $122 million of which is in weight loss. Higher soybean price at port terminals and greater quantity of screenings removed are the primary reasons for the greater value of weight loss.

Export elevators respond to foreign demand for cleanliness by making certain that the level of FM is within the grade limit specified in the purchasing contract. Otherwise, they can only receive prices of a lower quality grade. Overall, 43 percent of export elevators cleaned some soybeans and removed an average of 1.2 percentage points of FM.

Benefits of Cleaning Soybeans

Cleaning soybeans has potential benefits in both domestic and international markets. Domestic benefits occur in the form of improved storability. In addition, revenues generated from sales of screenings, while not the main reason for cleaning, offset a portion of the weight loss. International benefits are expressed in terms of premiums that foreign buyers would be willing to pay for cleaner soybeans or potential increases in the volume of U.S. soybean exports, based on information obtained from interviews with buyers in 11 importing countries selected for case studies.

Domestic Benefits

Producers and elevator operators regard avoiding weight deductions and/or price discounts for high levels of FM as the most important reasons for cleaning soybeans. In addition, soybean cleaning would improve storability and, in some rare cases, would result in premiums from buyers demanding cleaner soybeans.

Weight deduction is the most common practice charged to producers who deliver high-FM soybeans. FM in soybeans in excess of the 1-percent limit is often deducted from gross weight. According to the 1991 on-farm survey, 73 percent of producers indicated that weight deduction is the common discounting practice for high-FM soybeans. Only 8 percent of the respondents received no weight deduction. Over 85 percent of soybean sales by producers avoided weight deductions.

Similarly, processors or terminal elevators typically charge weight deductions on soybeans supplied by country elevators if the FM level exceeds 1 percent. In addition to weight deduction, country elevators are routinely charged price discounts, ranging from 0.2 cent per bushel for 1- to 2-percent FM to 1.4 cents per bushel for over 5-percent FM. This discount schedule, together with weight deduction, amounts to a greater penalty than the weight deduction applied to soybean producers. Discounts (including weight deductions and price discounts) assessed to commercial elevators are higher than those for producers because of the competitive market structure at the country elevator level. In the interest of maintaining customer loyalty, local elevators sometimes reduce or forgive discounts to producers.

Cleaning could improve storability and reduce the loss of dry matter (shrink) during storage. The removal of FM and fines extends the safe storage time of soybeans by improving airflow during aeration, which, in turn, can reduce mold growth and hot spots, and lessen insect damage.[7] Enhanced storability was cited by producers and country elevators as the second most important reason for cleaning soybeans. Since soybeans are not eligible for the Farmer-Owned Reserve (FOR), soybeans are typically stored within the marketing year, for up to a few months, primarily based on market conditions. Benefits from improved storability as a result of reducing the level of FM in all soybeans handled from 1.5 to 1.0 percent at country elevators are estimated to be 1 cent per bushel (Hurburgh, 1994). Country elevators realize greater benefits from improved storability because they assemble a large volume of soybeans from producers, approximately 80 percent of sales by producers. Export elevators and processors generally do not benefit from enhanced storability because soybeans are only temporarily stored at these facilities.

Revenue from screening sales to feeders and feed manufacturers partially offsets the value of weight loss that occurs during the cleaning process.

[7]Cleaner soybeans reduce the power requirement by reducing the cost of forcing air through the grain mass.

Screenings, a processed by-product feed which can substitute for energy feed ingredients, such as corn, are typically priced between 60 and 70 percent of the price of corn. In 1990/91, screenings sold by commercial elevators averaged about $56 per ton. The price of soybean screenings was the highest (around $80 per ton) during May-July, but dropped sharply to the range between $40 and $60 per ton just after harvest of the corn crop (Hyberg, Ash, and Just).

Additional cleaning would lower the relative market price of screenings because of the increase in the supply of screenings. However, the price of soybean screenings depends on the price of corn and its feeding value compared with that of corn. If additional cleaning applies to all exported soybeans, the supply of screenings would increase by 0.26 million ton (8.6 million bushels), a 32-percent increase over current levels, which were about 0.80 million tons (Ash, Lin, and Johnson). Based on estimated nutritional value and transport costs, the price of screenings would not fall below 60 percent of the price of corn under the additional cleaning scenario. Soybean screening prices might decline from $56/ton to $50/ton at country elevators as a result of the 32-percent increase in screening supply.

Gross benefits from additional cleaning of soybean exports are higher on the farm and at country elevators than river elevators and inland subterminals. These benefits include: the greatest potential for savings from reduced transportation costs, improved storability, and a higher value of screening sales if cleaning applies to all volume of soybeans handled by country elevators. Under the lower bound scenario, per bushel domestic benefits from cleaning all soybeans received at country elevators are estimated to be 2.7 cents. Gross domestic benefits from cleaning all soybeans received at country elevators total $35 million on a yearly basis. Benefits from additional cleaning at both inland subterminals and river elevators are estimated to be $14 million, because of smaller volume handled and minimal benefits from improved storability.

Cleaning soybeans at export elevators would result in larger benefits than at river elevators and inland subterminals because of the greater value of screening sales. Per-bushel benefits of cleaning at export elevators are estimated to average 5.1 cents, and aggregate benefits of cleaning all export soybeans at this market point are estimated to total $33 million per year, which is primarily derived from revenues of screening sales.

International Benefits

The international component of this study examines the role of quality in soybean importers' decisionmaking and assesses the potential economic benefits of selling cleaner U.S. soybeans in the world market. Soybean processors, traders, trade associations, livestock cooperatives, and government officials in 11 key soybean importing countries (Indonesia, Italy, Japan, Mexico, the Netherlands, Poland, Russia, South Korea, Spain, Taiwan, and Venezuela) were selected because they represent a cross-section of major importers of soybeans in terms of income levels and soybean end-uses. A series of interviews conducted in-country by teams of Economic Research Service analysts in 1992 formed the basis for each country study. These 10 countries (excluding Poland, which currently imports no U.S. soybeans) are among the largest importers of U.S. soybeans and typically account for 75 percent of all U.S. soybean exports and about two-thirds of world soybean trade.

The interviews revealed that although foreign buyers express a preference for clean soybeans, selling cleaner U.S. soybeans would have limited effects in improving U.S. competitiveness in the world oilseed market. Additional cleaning of U.S. soybeans could only help to maintain current U.S. market shares in selected Asian countries, notably in Japan and Taiwan. About 90 percent of soybeans imported by the 10 case-study countries were used for crushing, which places protein and oil contents as the top quality concerns, even more important than FM.

U.S. Soybean Prices

Processors in only a few country cases indicated a willingness to pay a small premium for cleaner soybeans, notably in Japan and Indonesia, where food use accounts for a large share of soybean imports (Mercier and Gohlke). To many of the processors interviewed, price, marketing factors (such as year-round supply and supply reliability), and protein and oil contents dominate cleanliness concerns in their import decisionmaking. In their view, the price difference between U.S. No. 1 and U.S. No. 2 exceeds the value of a 1-percentage-point lower FM and the lower level of damaged kernels and splits associated with U.S. No. 1. Also, those interested in low-FM soy-

beans can purchase from Brazil during part of the year without paying a higher price.[8] Moreover, many processors have become accustomed to the level of FM in U.S. soybeans because the FM level does not greatly impair operations. Some of the crushers are not certain that feed manufacturers or soybean oil refiners are willing to pay a premium for soybean meal or soybean oil that was crushed from low-FM beans. In the absence of that assurance from their customers, most soybean crushers were reluctant to indicate a willingness to pay a premium for cleaner U.S. soybeans that contain FM of less than 1 percent.

Revenue increases from selling cleaner U.S. soybeans with FM levels of 1 percent or less at a premium price to the 10 case-study countries are estimated to total between $4 and $5 million (Mercier and Gohlke). In Japan, crushers indicated a willingness to pay a premium of about 3.5 cents per bushel (or $1.3/mt) for cleaner U.S. soybeans. The premium that food processors are willing to pay would be slightly higher, 5-6 cents per bushel or $2.0/mt.[9] Food soybean processors in Indonesia indicated a willingness to pay a premium up to 4 percent of the import price, or about $10/mt, for cleaner U.S. soybeans with a 1-percentage-point reduction in FM. However, this revenue impact is a meager increase of $0.3 million because of a small volume of U.S. soybean exports to Indonesia for food processing. Also, food processors there most likely already purchase U. S. No. 1 for food use, which has a FM limit of 1 percent. Hence, cleaner soybeans to command the premium may require lowering FM to near 0 percent, which may not be practical to serve the majority of buyers. Single processors interviewed in Spain and Venezuela expressed interest in paying premiums for low-FM beans, but their impact on U.S. soybean trade is likely negligible.

Soybean food processors buy a higher percentage of U.S. No. 1 soybeans than do soybean crushers. These food processors are concerned with protein content, FM, and splits, and may require tighter standards for FM, splits, and damaged kernels. Soybean food processors offer hefty premiums to some U.S. producers by entering into direct contracts where the identity of individual soybean shipments from country elevators is preserved. Contract specifications often call for deliveries of soybeans with less than 0.5-percent FM, a very low limit of seed damage or splits, and require large-seeded varieties with clear or light hilum. In addition, growers are frequently subject to restrictions placed by buyers on field operations and production/harvesting practices. In return, the producers are awarded with price premiums typically in the range of $1.50-$2.00 per bushel. Food soybeans are often shipped in containers. Container shipments account for about 200,000 tons a year, nearly 20 percent of total food-grade soybeans imported by Japan under identity preserved (IP) contracts (Guinn).

Almost all food processors contracted with producers on an IP basis 10 or 15 years ago. However, most tofu processors in Asian countries (such as South Korea and Japan) purchased U.S. beans largely on a numeric grade basis in recent years. Because many of them already pay more for buying U.S. No. 1, they are less inclined to pay an even higher premium for clean soybeans. For other processors who currently purchase U.S. No. 2 for food processing, no respondents indicated they would anticipate a net benefit from making a switch to U.S. No. 1 with lower FM.

U.S. Soybean Exports

Even if cleaner soybeans were offered to foreign buyers, the prospects are limited for any expansion of U.S. soybean exports in the study countries. At best, cleaner U.S. soybeans could help stem a potential loss of U.S. market share in selected cleanliness-conscious Asian markets, notably Japan and Taiwan. U.S. soybean exports to these two countries would not fall by between 100,000 and 200,000 tons (from current combined levels of nearly 6.5 million tons of U.S. exports) if low-FM soybeans were offered at the same prevailing price. The Japanese share of that potential decline would be between 50,000 and 100,000 tons, and the Taiwanese share would be similar. The Uruguay Round Agreement under the auspices of the General Agreement on Tariffs and Trade (GATT), however, is expected to lessen use of export subsidies for feed grains, which could make soybean imports more price attractive and boost the growth prospect of U.S. soybean exports.

[8]Brazilian soybeans, in fact, were priced (c&f) $6-$8 per metric ton lower than U.S. soybeans in Japan in recent years. During 1990/91, landed prices of Brazilian soybeans averaged $261 per metric ton, compared with $269 for U.S. soybeans.

[9]This premium can barely cover the domestic net cost of additional cleaning, 6.6 cents per bushel at the least net-cost locations—river elevators and inland subterminals.

If the market price of cleaner U.S. soybeans reflects the cost of additional cleaning, then much of these trade increases would disappear. This is especially true for the trade effect in Japan where the potential retention of market share must be regarded as optimistic because it is based on the assumption that Japanese buyers would pay no more for cleaner U.S. soybeans. The net gain in terms of potential retention of U.S. market share would largely disappear if foreign buyers were expected to pay premium prices for cleaner U.S. soybeans. Thus, shortrun gains in terms of retention of U.S. market share would be reduced to about 50,000 tons, primarily through the retention of U.S. market share in Taiwanese soybean imports.

Accordingly, the U.S. soybean industry, in addition to the $4-$5 million price benefits, would potentially benefit by about $2 million from the retention of U.S. market share in Taiwanese soybean imports, or about 50,000 metric tons. First, revenue from U.S. soybean exports would increase by about $10.3 million, assuming a $206-per-metric-ton f.o.b. (free on board) export price for 1991/92. However, the net benefit of this increase in export revenues would be reduced by the $7.3 million cash costs of production (based on cash costs of $3.98 per bushel), $0.7 million transportation costs from the farm to the export port (based on a $14-per-metric-ton transportation rate), and an additional $0.2 million costs of cleaning (based on a cleaning cost of 9.6 cents per bushel).[10] The $2 million in net benefits from the retention of U.S. market share in Taiwanese soybean imports must be regarded as an upper bound (at least for countries surveyed) because costs of cleaning potentially lead to higher U.S. soybean selling prices which, in turn, would reduce the retention of U.S. market share.

Unless foreign buyers are willing to absorb the domestic net cost of additional cleaning, 6.6 cents per bushel at least net-cost locations, the cost of additional cleaning would eventually be passed back by export elevators to interior elevators and producers. By imposing this cost on the U.S. production-marketing system, cleaner soybeans would raise the price that foreign buyers pay for U.S. soybeans and would reduce imports from the United States. In addition, the prospects of any expansion of U.S. soybean exports are further limited because U.S. soybeans already dominate many important export markets, especially Mexico, Venezuela, Taiwan, South Korea, Russia, and Japan. Many crushers have become accustomed to the level of FM in U.S. soybeans. Since the FM can be removed prior to processing, it does not necessarily alter the end-use quality of soybeans.

Responses from competitors to cleaner U.S. soybeans would not likely alter the fundamental quality competitiveness of the United States vis-a-vis competitors. Comparable FM levels between Brazil and the United States would leave Brazilian beans preferred on the basis of other quality factors, notably oil content, but still fall short in terms of year-round availability and supply reliability (Mercier and Gohlke). The characteristics of Chinese soybeans, such as larger-sized seeds and higher carbohydrate levels, make them more suited for food processing than crushing. The lower protein content in Chinese soybeans renders them less desirable for use in the feed market in many countries.

Net Costs of Cleaning Soybeans

Would international benefits (combined premium benefits and trade effects) from selling cleaner soybeans be sufficient to compensate for the $26 million domestic net costs (under the more likely lower bound cost scenario) for additional cleaning of U.S. exported soybeans at both river elevators and inland subterminals—the lowest net cost locations?

The international benefits from additional cleaning are only modest relative to the domestic net cost of cleaning. The potential sources of benefits that were identified from the 10 case-study countries are: (1) $4-$5 million premiums that foreign buyers would be willing to pay for low-FM U.S. soybeans, and (2) $2 million additional net gains in terms of potential retention of U.S. market share in few cleanliness-conscious, Asian markets (notably Japan and Taiwan). The $13.5 million in annual domestic benefits (under the lower bound cost scenario) and $6.5 million in international benefits that would result from additional cleaning of export soybeans at both inland subterminals and river elevators are not enough to compensate for the $40 million it would cost to perform additional cleaning of export soybeans at these locations every year. The benefits and net costs of cleaning at both inland subterminals and river elevators, under the

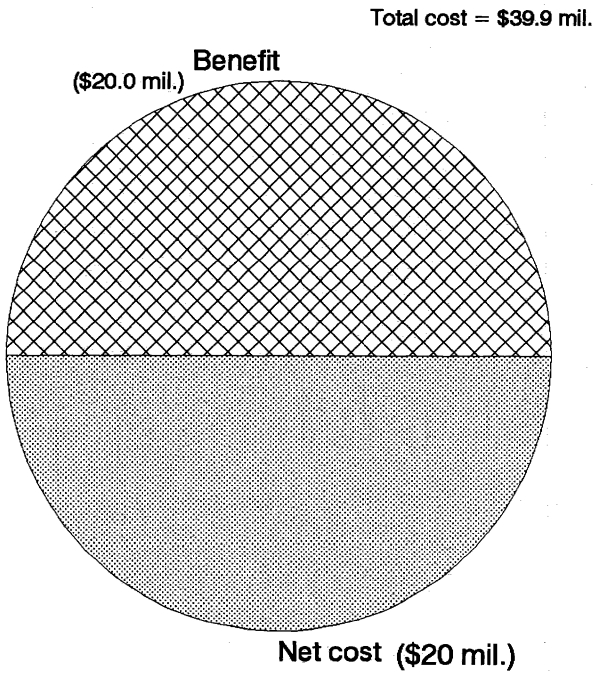
[10]The additional costs of cleaning also need to be factored into this calculation because the costs of cleaning reported in table 1 do not include this additional 50,000-ton retention of U.S. market share in Taiwanese soybean imports.

lower bound scenario, are illustrated in figure 2 and table 3.

The data clearly indicate that cleaning all U.S. export soybeans beyond the current level would result in, at minimum, a net cost of $20 million per year, even if the additional cleaning is performed at the least net-cost locations.

Selling low-FM U.S. soybeans to Japan, although commanding premium benefits, still would result in a net cost of $3.2 million. In 1992, Japan imported 4.5 million metric tons of soybeans, of which 82.5 percent came from the United States. Premium benefits from exporting clean soybeans to Japan would increase export revenues by $5.3 million ($3.9 million for crush and $1.4 million for food). However, this premium benefit would still fall short of meeting domestic net cost, which is estimated at $8.5 million (6.2 cents/bu. x 3.71 million metric tons) if cleaning occurs at river elevators and inland subterminals.

Figure 2
The net cost of cleaning U.S. export soybeans at the least-cost location (lower bound scenario), 1991



River elevators and inland subterminals.

Source: Economic Research Service.

Importers' Purchase Decisions

Buyers' decisions in choosing soybean suppliers are influenced by price, quality (including cleanliness), trade-servicing reliability, transportation costs, and other competitive factors. The United States continues to dominate the world soybean trade in part because of its ability to supply soybeans year-round and reliability of timely supply. However, many importers appear to treat the United States as the residual supplier, preferring to buy soybeans from Brazil and other competitors as long as their supplies last. Brazilian soybeans not only contain higher oil content and lower FM, but also are often priced slightly lower than U.S. beans in many markets.

Interviews with foreign buyers revealed that quality ranks second to price in import decisionmaking, particularly among feed-use buyers, although the two factors are closely related through the crushing margin (Mercier and Gohlke). Quality is also important to food processors, with the strongest export competition coming from China.

Table 3—Domestic net costs versus international benefits of soybean cleaning

Item	Lower bound	Upper bound
	Million dollars	
Domestic net costs at least net-cost locations:		
Costs—		
Weight loss	30.6	91.8
Cost of operating cleaner	7.7	4.7
Transportation of screenings	1.6	2.7
Domestic benefits—		
Screening sales	13.5	23.0
Domestic net costs	26.4	76.2
International benefits:		
U.S. soybean prices	4-5	4-5
U.S. soybean exports	2	2
Subtotal	6.5	6.5
Net costs of cleaning	20.0	70.0

Source: Economic Research Service.

Price Versus Quality Considerations

Price and the perceived quality of soybeans imported, although separate factors in the importers' decisionmaking, are often strongly related through the crushing margin and treated as trade-offs by many buyers. Price was regarded as the most important sourcing factor affecting importers' purchase decision in most importing countries studied (table 4). Figure 3 illustrates the relative importance of factors influencing importers in selecting suppliers of soybeans.[11]

Foreign buyers prefer to import soybeans and soybean products from Brazil and Argentina in part because of disincentives for storage after soybeans are harvested in these countries. Brazilian and Argentine soybeans are priced below those from the United States during the prime marketing season (March-September).

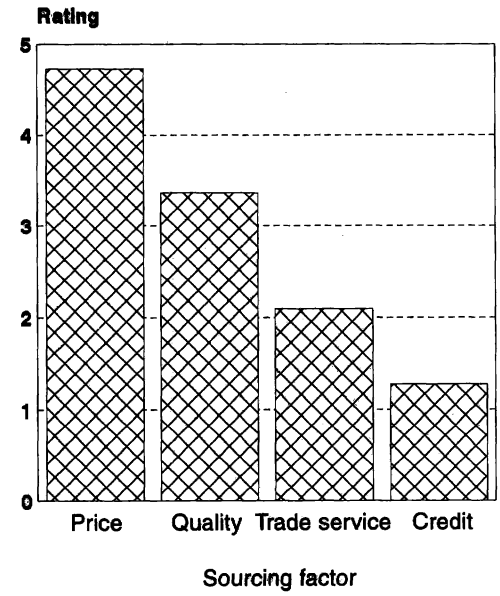
Importers who import soybeans for crushing evaluate relative prices between suppliers of soybeans within a context of soybean yields of protein and oil. Since Brazilian soybeans generally yield more oil and protein from crushing than do U.S. soybeans, foreign buyers benefit not only from the lower Brazilian price but also from the better soybean quality. Foreign buyers' quality preferences differ depending on soybeans' end-use. If the soybeans are destined for food processing, importers prefer high carbohydrate content, large-sized seeds with clear or light-colored hilum, low percentage of splits and damaged kernels, and low FM. If the soybeans are intended for feed manufacturing, however, the importer is more likely to compare the value of soybeans' protein and oil contents with other oilseeds.

While Brazilian and Argentine soybeans are often priced lower than U.S. soybeans due to their lower costs of production and lack of storage facilities, U.S. soybeans are price competitive in Western Hemisphere markets, such as Mexico and Venezuela. This competitiveness stems mostly from lower shipping charges, considerably lower from U.S. Gulf ports than from major Argentine and Brazilian ports. Similarly, lower transport costs give China a price advantage in Asian markets, such as Indonesia and Korea. Brazilian soybeans were priced about $6-$8 per metric ton lower than U.S. soybeans in the Japanese soybean market in 1992.

Many foreign buyers view price and quality as trade-offs because they are willing to pay higher prices for better-quality soybeans. Surveys of soybean quality at foreign destinations have indicated that soybeans purchased from Brazil receive premiums because of their higher oil content (Nicholas and Whitten; Nicholas; Mounts and others; and Hurburgh and others, 1990). Also, foreign buyers often specified quality needs for food soybeans even tighter than U.S. No. 1. For example, Japanese food processors that enter into direct contracts with U.S. producers in the Midwest often specify less than 0.5-percent FM, a very low limit of seed damage and splits, and require large-seeded varieties with clear or light-colored hilum. Taiwanese crushers also specify a maximum 1.5-percent FM in contracts despite the 2-percent FM limit of U.S. No. 2.

Figure 3

Average rating of most important sourcing factors identified by soybean importers, 1991



Rating values assigned: 5 = most important; 1 = least important.

Source: Economic Research Service.

[11]The relative importance of sourcing factors is determined by giving a ranking value of 5 to the No. 1 sourcing factor, and a ranking value of 4 to the No. 2 sourcing factor, and so forth. The average ranking of each sourcing factor is computed by dividing the sum of ranking values for that sourcing factor by the number 11 (the number of countries interviewed).

Table 4—Importers' ranking of soybean sourcing factors by country

Importing country	Imported volume	Market share				Ranking of sourcing factors #1	#2	#3	#4
	Million tons	*Percent*							
Indonesia	beans--0.53 meal--0.19 oil--0	Food: China U.S.	 91 8	Feed: China U.S. Arg.	 44 44 12	Reliability of supply (timing of shipment)	Price	Quality	
Italy	beans--1.34 meal--1.5 oil--0.012	Beans: Arg. Brz. U.S.	 33 24 20	Meal: Brz. Arg. U.S.	 68 17 11	Price	Quality (Protein)	Seasonal availability	
Japan	beans--4.5 meal--0.8 oil--0	Food: U.S. China Other	 56 28 16	Feed: U.S. Brz.	 78 22	Price	Quality	Seasonal availability	
Mexico	beans--2.2 meal--0.4 oil--0.075	Beans: U.S.	 100	Meal: U.S.	 100	Price	Credit availability	Quality	Timely shipments
The Netherlands	beans--4.37 meal--1.38 oil--0.03	Beans: U.S. Brz. Arg.	 53 26 17			Price	Cleanliness	Intrinsic quality	Trade servicing
Poland	beans--0.5 meal--0.6	Beans: EC	 100			Price	Intrinsic quality	Contract execution	Government regulations

---Continued

Table 4—Importers' ranking of soybean sourcing factors by country--Continued

Importing country	Imported volume	Market share				Ranking of sourcing factors #1	#2	#3	#4
	Million tons	*Percent*							
Russia	beans--0.14	Beans:		Meal:		Credit availability	Price		
	meal--1.0	U.S.	90	U.S.	60				
	oil--0.2	Arg.	5	Arg.	8				
				EC	7				
				Brz.	6				
South Korea	beans--1.1	Beans:		Meal:		Price	Quality		
	meal--0.72	U.S.	90	China	36				
	oil--0.011	Brz.	3	Brz.	20				
				India	11				
				Others	32				
Spain	beans--2.56	Beans:		Meal:		Price	Quality	Trade servicing/ Company relationships	
	meal--1.5	U.S.	61	Brz.	58				
	oil--0	Brz.	26	Arg.	35				
		Arg.	9	U.S.	3				
Taiwan	beans--1.96	Beans:				Price	Quality	Supply reliability	
	meal--0.2	U.S.	97						
	oil--0.005	Arg.	3						
Venezuela	beans--0.16	Beans:		Meal:		Credit	Price	Quality	
	meal--0.55	U.S.	100	U.S.	87				
	oil--0.13			Brz.	9				

Within the general category of quality factors, most importers regard protein content, oil content, moisture, and FM to be the most important quality characteristics (table 5).[12] Figure 4 illustrates the relative importance of various quality factors. Protein content or consistency is the most important factor to 7 out of the 11 case-study countries. Although trailing protein and oil contents and moisture as a sourcing criterion, FM is of concern to crushers and feed compounders because it detracts from grain storability and poses a risk in failing to meet the protein requirement of soybean meal. The presence of FM can contaminate the products in soybean food processing, reduce milling yield, and is often associated with low protein content. Taste and consumer acceptance are the key concerns for food processors. Moisture content helps determine soybean storability. Moisture at 13.5 percent or higher is viewed as excessive and can cause mold growth and insect damage during shipments and storage.

Importance of Foreign Material

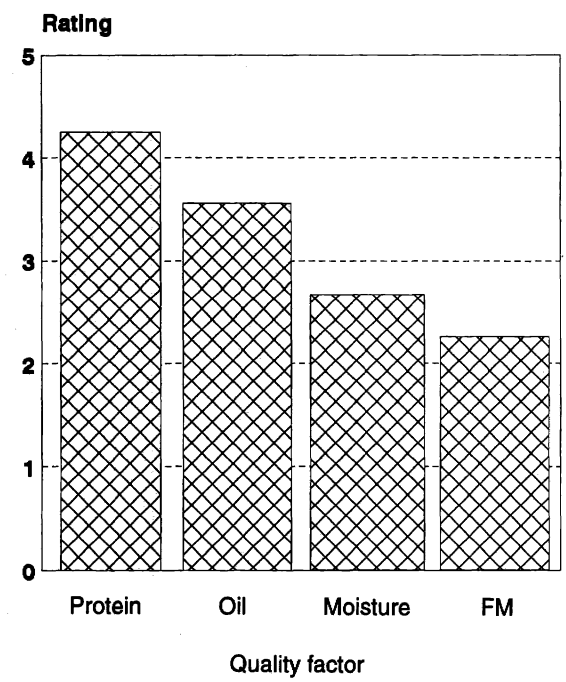
FM, next to protein and oil contents and moisture, was an important quality characteristic that influences importers' purchase decisions. High-FM soybeans reduce milling yield, and pose a risk to bean crushers in failing to meet the protein and fiber requirements for soymeal. Under normal circumstances, crushers must meet specifications of 44 and 48 percent protein at 12-percent moisture for low- and high-protein meals, respectively. This means that protein content of soybeans cannot be much below 35 percent for producing the low-protein soymeal. In addition, crushers often require a 7-percent maximum limit for fiber in soymeal. High-FM soybeans also pose a risk of failing to meet the fiber limit. FM ranks among the top 4 most important quality factors in 8 out of the 11 case-study countries, and as high as second in 2 countries (the Netherlands and Russia). Many importers receive a guarantee of 1-percent FM or less in buying Brazilian soybeans, half the level of U.S. No. 2 soybeans. Only in Taiwan did respondents indicate that they specify FM levels which are tighter than the FM limits of the U.S. soybean grades and standards. The key complaint about high FM in U.S. soybeans was expressed along the line of reluctance to "pay good money for material that does not yield meal and oil" (Mercier and Gohlke). Other issues include the cost of screening disposal, a higher share of quarantine seeds or insect damage, and adverse effects on soybeans' storability and processing performance.

The FM level in U.S. soybeans in many export markets has gradually improved in recent years. Average FM levels in U.S. soybean exports improved for 8 of the 10 countries between 1986 and 1992, although FM content was reduced by less than 3 percent in all but 4 countries (Mercier and Gohlke). Only in the case of Italy can the FM decrease be attributed solely to a overall shift in the dominant grade of U.S. soybeans purchased. For Japan, Mexico, Taiwan, and South Korea, the share of U.S. No. 2 soybeans imported remained relatively stable.

Cleanliness and Quality as Competitive Factors

While the United States dominates the world soybean market, Brazilian soybeans are perceived to be cleaner

Figure 4
Average rating of most important quality factors identified by soybean importers, 1991



Rating values assigned: 5 = most important; 1 = least important.

Source: Economic Research Service.

[12]In Spain, protein and oil contents were rated as equally important.

Table 5—Importers' ranking of soybean quality factors by country

Importing country	Use breakdown	Ranking of quality factors			
		#1	#2	#3	#4
Indonesia	Food--60% Crush--40%	Protein Oil	Moisture content	Test weight	
Italy	Crush--99% Food--1%	Protein consistency	Moisture content	FM	
Japan	Crush--81% Food--19%	Oil content	Protein content	Color	Kernel size/FM
Mexico	Crush--100%	Protein	Oil	Moisture	
The Netherlands	Crush--91% Feed--9%	Oil content	FM	Moisture	Protein content
Poland	Crush--100%	Protein content	Fiber	Oil content	Protein consistency/ Free fatty acids
Russia	Crush--97% Food--3%	Splits	FM	Oil content	Quarantine seeds
South Korea	Crush--67% Food--33%	Protein content	Oil content	FM	
Spain	Crush--86% Feed--14%	Protein content	Oil content	FM	Moisture
Taiwan	Crush--84% Food--12% Direct feed--4%	Protein content	Oil content	FM	Splits
Venezuela	Crush--99% Food--1%	Moisture	Protein content	FM	Free fatty acids/ Oil content

and of higher quality than soybeans exported by the United States. This quality preference stems from the perception of Brazilian beans being consistently higher in both protein and oil contents than U.S. soybeans, and consistently lower in FM content, according to the interviews with foreign buyers. Brazilian soybeans, however, are sometimes avoided because of darker color in Brazilian soybean oil and red color in meals produced from Brazilian beans, both a direct result of reddish tint of soil in Brazil. This is particularly true in some Asian markets, such as Japan and Taiwan.

Argentine soybeans are viewed by importers in some markets as inferior in quality to Brazilian or U.S. beans, due to lower protein content and oil contents, although other factors such as smaller kernel size, lack of uniformity, and the same red coloring which plagues Brazilian beans are also cited.

Policy Implications

The origination of FM from the farm is the crux of the soybean cleaning issue. Policies designed to enhance the cleanliness of U.S. soybeans must address the issue of lowering FM through changes in production and harvesting practices. Since soybean FM primarily consists of plant parts, broken beans, weed seeds, and dirt, these materials can be reduced by better weed control, combine adjustment, and harvesting soybeans at proper moisture level. One strategy to address the soybean cleanliness issue is to create incentives for producers to alter production and harvesting practices, especially to target producers who could lower FM in soybeans with little or no additional cost.

Lowering soybean FM by altering production and harvesting practices offers an alternative to mechanical cleaning, but needs to be more fully evaluated for its cost-effectiveness. The net cost of additional cleaning of export soybeans is estimated to total $20 million per year, at minimum, even if additional cleaning occurs at the least net-cost locations—river elevators and inland subterminals. Although it does not pay for producers to universally deliver cleaner soybeans, 11 percent of soybean producers currently delivering soybeans with FM levels greater than 0.5 percent indicated that they could deliver clean soybeans with less than 0.5-percent FM at little or no additional cash cost by changing harvesting and handling practices. However, changing harvesting and handling practices may involve some costs as a result of adjusting labor or equipment usage. Also, increased harvest time may be required, which involves additional costs. No geographic profile of these 11 percent of producers is available due to a small response rate of the on-farm survey, although it is likely they are primarily Midwest producers. Additional incentives to these producers could trigger such changes and enhance the cleanliness of U.S. export soybeans.

It would be impractical to clean all export soybeans only at river elevators and inland subterminals, even though these are the least net-cost market points of additional cleaning. Export soybeans are also handled by country and export elevators, and breakage occurs during handling. Thus, additional cleaning at the subterminal elevators alone would not guarantee a low level of FM (not greater than 1 percent prior to loading). Producers and country elevators would have to continue their current cleaning practices. Export elevators would also have to continue cleaning at the current level to ensure FM levels within the lower target at FGIS inspection.

Marketing soybeans with a FM content below the current level requires more incentives than currently exist in the marketplace. These incentives must come from domestic and foreign buyers as premiums or in increased trade. Techniques to remove FM by changing production and harvesting practices exist in the marketplace, including herbicide use, drilled planting, and combine adjustment. A small percentage of soybean producers would deliver clean soybeans by altering their harvesting and handling practices if there were more incentives for marketing low-FM soybeans than currently exist in the marketplace.

Policy Options

This report extends beyond the context of the domestic and international reports by examining various policy options to improve the cleanliness of U.S. soybeans and to better meet the quality needs of domestic and foreign buyers. Policy options to reduce the level of FM in U.S. soybeans must include incentives for producers to lower FM by changing production and harvesting practices. Although additional cleaning on a universal basis is not economically viable, options, such as lowering the grade limits for FM, may create incentives for a segment of producers to deliver clean soybeans by changing harvesting and handling prac-

tices. The issues of testing protein and oil contents and improving protein and oil yields of U.S. soybeans through plant breeding and genetics research are also addressed because protein and oil contents are two of the most important intrinsic characteristics from the viewpoint of foreign buyers. Finally, this report examines an information program designed to enhance U.S. quality competitiveness.

Options to lower FM in U.S. export soybeans or to enhance U.S. quality competitiveness must be evaluated for their cost-effectiveness before serious consideration is given to adopting them.

Changing U.S. Grades and Standards for Soybeans

Foreign buyers often perceive soybeans exported from the United States as not as clean as soybeans exported by competitors, such as Brazil, Argentina, and China. Although annual averages for FM in U.S. export soybeans at loading are below contract specification, some foreign buyers (especially in Europe) have complained about receiving U.S. soybeans with levels of FM that exceed the 2-percent limit for the base grade U.S. No. 2. More important, foreign buyers can differentiate U.S. export soybeans from soybeans exported by competitors. During 1990-94, the FM level for U.S. soybeans shipped to all destinations and reported on export certificates at loading averaged 1.7 percent, down from 1.9 percent during 1982-89. In contrast, the FM in Argentine soybeans was reported to average only 0.48 percent during 1982-89, and the FM in Brazilian beans exported to Japan averaged 0.6 percent in 1989 (Bender, Hill, and Valdes; Japanese Oilseed Processors Association).[13]

Two options for improving cleanliness of U.S. export soybeans within the grades and standards framework were examined. These included a proposal to lower the FM limits investigated by the Federal Grain Inspection Service in 1991 and a removal of FM as a grade-determining factor, with mandatory reporting.

Lowering the Grade Limits for FM

Changing the grade limit itself may not necessarily result in additional cleaning, depending on whether foreign buyers switch the grade of soybeans purchased or not. Contract specification would ultimately determine whether additional cleaning follows a reduction in the grade limit for FM. If foreign buyers retain U.S. No. 2 as their base grade, export elevators would have to supply cleaner soybeans or accept prices of a lower quality grade. However, if foreign buyers simply switch their imports from U.S. No. 2 to U.S. No. 3 and the FM limit for the latter were the 2-percent maximum, then there would be little change in the FM level for U.S. soybean exports.

Under this option, the grade limits for FM would be reduced by one-half, from 1.0 to 0.5 percent for U.S. No. 1 and from 2.0 to 1.0 percent for U.S. No. 2, respectively, as proposed by the FGIS in 1991. This FM proposal has not yet been acted on, although intense debate persists, pitting handlers against exporters and some growers (Hurburgh, 1994). Soybean prices for the new base grade under this option would be higher than those for the current base grade if the marketplace adjusts, but soybeans with a FM level higher than this new, lower grade limit would be subject to price discounts in domestic markets.

As with any proposal, there are pros and cons for this option:

Pros:

- Lowering the grade limits for the FM factor might induce changes in producers' production and harvesting practices or additional soybean cleaning because of the incentive to deliver cleaner soybeans if the marketplace adjusts its base price. Altogether, nearly 40 percent of soybean producers responding to a voluntary survey indicated that they can then deliver soybeans that meet the new, lower FM limit for U.S. No. 1.

- Additional incentives would be offered for cleaner soybeans if weight deduction began at a FM level of 0.5 percent and the discount in dollar terms were higher, reflecting a higher base price for cleaner soybeans and possibly a more stiff price discount (over and above weight deduction) charged by processors.

- Soybeans will be priced according to their value of cleanliness and other quality characteristics of value to buyers and end-users.

[13]No FM data in more recent years are available for soybeans exported from Argentina and Brazil.

Cons:

- The total net costs of additional cleaning to remove 1 percentage point of FM from export soybeans, under the current market structure, would, at minimum, exceed $20 million a year.

- Lowering the grade limits for FM is unwarranted because foreign buyers can purchase cleaner soybeans (but at higher prices) under the current U.S. grades and standards by specifying U.S. No. 1 in their contracts.

- Lowering the FM grade limits may not improve cleanliness of U.S. export soybeans if foreign buyers simply switch their purchases from the current U.S. No. 2 base grade to a higher numeric grade, such as U.S. No. 3. This option does not force buyers to choose cleaner soybeans, and it will not dictate market response (Hill, Bender, and Beachy).

- This option may not resolve the dissatisfaction of foreign buyers because FM in U.S. export soybeans would probably still exceed the new, lower FM limit for the grade they purchased when delivered at foreign destinations.

Removing FM as a Grade-Determining Factor

An alternative to lowering the FM limits in U.S. soybean grades and standards is to remove FM as a grade-determining factor, but require its reporting. Buyers and sellers are free to negotiate a contract specification which spells out rules for governing the trade.

Under this alternative, FM would be measured with the present procedure, and reported separately on FGIS export certificates, but would not be grade-determining. Thus, except for damaged kernels and splits, the grade-determining factors will be those of least importance, as measured by current market discounts (Hurburgh, 1994).

This alternative would eliminate all structural incentives for delivering low-FM soybeans and raise questions over why have grades at all (Hurburgh, 1994). However, processors and domestic elevators would likely continue their current purchasing practices. Country elevators probably will continue to apply weight deductions to producers' soybeans with FM levels above 1 percent. In this case, the FM level of soybeans delivered by producers and country and subterminal elevators would probably remain unchanged.

Exporters and foreign buyers would be most affected by this option. Both the exporter and foreign buyer would be forced to set a contract specification outside the grade structure, which had mixed success in the past. Foreign buyers will lose their advantage of knowing with certainty the FM level at maximum, and will weaken buyers' bargaining position in forcing the exporters to supply soybeans with FM levels within the grade limits or to accept prices of a lower quality grade. To exporters, the needs of setting a contract specification for each buyer would complicate the negotiation of contracts and would likely cause more confusion and raise costs in the many support operations for exports (Hurburgh, 1994).

Finally, this alternative will probably be resisted by importers. To them, all perceived advantages of trading within a structured grades and standards framework would be lost, and considerable training would be needed to familiarize the process of setting contract specification outside the grade structure. More disputes between exporters and foreign buyers are anticipated, and may take longer to resolve because the United States has no formal dispute resolution mechanism in its marketing system.

Improving Oil and Protein Yields Through Plant Breeding and Genetics Research

An inverse relationship often exists between yields and intrinsic quality characteristics, such as protein content and oil content. Soybean breeders generally seek to increase yields and improve disease resistance. Quality characteristics, although important, may not be emphasized because of the lack of sufficient market incentives. Yet, the plant breeding and release of genotypes with both higher protein and oil contents and acceptable yield potential could be an effective option for enhancing quality competitiveness of U.S. export soybeans.

Although foreign buyers have shown strong preference for high-protein and high-oil soybeans, protein content and oil content have not received priority attention in soybean plant breeding.[14] As a result,

[14]State Agricultural Experiment Stations and private seed companies are the primary locations of soybean breeding programs. Most soybean breeding is conducted by private seed companies.

despite the U.S. reputation as a reliable supplier of soybeans, the United States is also known as a residual supplier (as long as competitors' supplies last) due to U.S. soybeans' higher FM and lower protein and oil contents, and the fact that foreign buyers can buy better-quality soybeans from competitors without having to pay a higher price. During 1986-89, Brazilian soybeans showed an average of 0.4-percent higher protein content and 1.2-percent higher oil content than U.S. soybeans (Mounts and others). More incentives for marketing high-protein and high-oil soybeans are needed if the quality competitiveness issue of U.S. soybeans is to be effectively addressed.

The 1990 Grain Quality Incentive Act (Title XX) requires that grain submitted for public testing be evaluated for selected specific agronomic performance and intrinsic end-use characteristics. USDA is to disseminate this information to plant breeders, producers, and end-users. The Department is also required to periodically conduct a survey of grain varieties produced in the United States. Appropriate funding for these activities as well as funding for the development and release of varieties with high protein and oil contents could be beneficial in the long run.

Breeders and institutions exercise tremendous discretion in developing and releasing new soybean varieties. Under the current market structure, genotypes with improved protein and oil contents but lower yield potential would not be popular and probably would not be released. The marketplace would need to offer incentives to deliver soybeans with higher protein and oil contents if varieties with these characteristics are to be adopted. Otherwise, producers will not demand seed with the desired improvements, and plant breeders will not pay close attention to these intrinsic characteristics.

Mandatory Testing and Reporting of Protein and Oil Contents

Foreign buyers perceive competitors' soybeans as not only cleaner than U.S. beans but also with higher protein and oil contents. This perception is related to a tighter FM standard and mandatory testing and reporting of oil content for competitors' soybeans. For example, "export quality" soybeans from Brazil are tested for oil content before shipments, and are only permitted to have 1-percent FM.

An alternative to improving protein and oil yields through plant breeding and genetics research is to mandate testing and reporting of protein and oil contents on FGIS inspection certificates. At present, protein and oil contents are tested and reported if requested by foreign buyers. In 1992, about 60 percent of foreign buyers made such a request. A more active approach would be to make testing and reporting these factors mandatory before shipments. The testing and reporting would provide foreign buyers with information about soybeans' essential quality without a prior request from foreign buyers. It would send clear signals to foreign buyers that U.S. soybean exporters are serious in meeting their customers' quality needs. Foreign buyers, in turn, can utilize this information to specify the origin of soybean supply in contracts to ensure their protein and oil content requirements, and to ensure uniformity of soybean quality.

Launching an Information Program To Enhance U.S. Quality Competitiveness

Foreign buyers' perception of U.S. soybean quality being inferior to Brazilian soybeans might reflect the fact that most foreign buyers are not familiar with the protein and oil contents of U.S. soybeans by regional origin. Unlike domestic buyers who generally are aware of protein and oil contents of soybeans grown in different parts of the United States, foreign buyers have rather limited basis to differentiate, for example, high-oil soybeans from low-oil soybeans and their supply origins. As a result, they mostly resolve this uncertainty by setting minimum requirements in their contracts. However, since protein and oil contents are not grade-determining factors, they are tested and reported only if foreign buyers make such a request. This lack of information about U.S. soybean quality does not contribute positively to the image of U.S. soybean quality and certainly does not help to ensure uniformity of U.S. soybean quality.

A more active approach than the status quo is to launch an information program to target buyers and sellers alike and one function would be to familiarize foreign buyers with the important intrinsic quality characteristics, such as protein content and oil content. Thus, these buyers can maximize their chance to receive soybeans with certain oil content, for example, by specifying the origin (location) of soybean supply.

This approach would contribute to more uniform quality of U.S. soybeans. In addition, this information program can be used to educate producers about how to properly adjust their combines to lower FM in harvested soybeans. Finally, this information program can be used to convey foreign buyers' quality preferences to exporters, handlers, producers, and plant breeders.

Conclusions

Cleaning all U.S. export soybeans beyond the current level is not economically feasible because the costs of cleaning at the least net-cost locations—river elevators and inland subterminals—would exceed the benefits by, at minimum, $20 million per year.

The bulk of potential benefits from marketing cleaner soybeans comes from domestic markets. The removal of FM and fines would reduce mold growth and insect infestation, and thus improve storability. Revenues from screening sales to feeders and feed manufacturers partially offset the value of weight loss that occurs during the cleaning process. Producers and commercial elevators cited avoiding weight deductions and/or price discounts as the most important reasons for cleaning soybeans. FM in soybeans in excess of the 1-percent limit is often deducted from gross weight.

The potential international benefits from additional cleaning are only modest, relative to the domestic net cost of cleaning. The potential sources of benefits in international markets are: (1) $4-$5 million premiums that foreign buyers would be willing to pay for low-FM U.S. soybeans, and (2) $2 million net gain in terms of potential retention of U.S. market share in a few cleanliness-conscious Asian markets (notably Japan and Taiwan). Processors in only a few country cases indicated a willingness to pay a small premium for cleaner beans, notably in Japan and Indonesia, where food use accounts for a large share of soybean imports. Although foreign buyers express a preference for clean soybeans, selling cleaner U.S. soybeans seems to have limited effects in improving U.S. competitiveness in the world market. At best, cleaner U.S. soybeans could help stem loss of U.S. market share in the few Asian markets.

One way to address the soybean cleanliness issue is to create incentives for producers to alter production and harvesting practices. Plant parts, broken beans, and weed seeds are the main components of FM in soybeans at harvest, which can be reduced by better weed control and combine adjustment.

The costs of additional cleaning exceeded benefits in both domestic and international markets at all points in the production-marketing system. Performing additional cleaning of U.S. export soybeans at both river elevators and inland subterminals had the least net cost because of a smaller cleaning volume than at the farm or country elevators and a lower value of weight loss than at export elevators. The net costs of cleaning averaged 6.2 cents per bushel of soybeans cleaned at both of these subterminals.

Most soybean FM originates from the farm. The level of FM at harvest averages 1.3 percent. FM in soybeans grown in the South generally is double the FM in soybeans grown in the Corn Belt. The FM level in U.S. soybeans increases as soybeans move from the farm gate to country elevators, river elevators or inland subterminals, and port elevators. The FM level increases to 1.5 percent when soybeans are delivered to country elevators and subterminals, and 1.8 percent by the time soybeans arrive at export elevators. During 1990-93, the FM level of U.S. soybean exports averaged 1.7 percent.

Buyers' decisions in choosing soybean suppliers are influenced by price, quality (including cleanliness), trade-servicing reliability, transportation costs, and other competitive factors. Price was regarded as the most important sourcing factor affecting importers' purchase decisions in most importing countries studied, although prices and the perceived quality of soybeans imported are closely related. Foreign buyers prefer to import soybeans and soybean products from Brazil and Argentina. In part because of disincentives for storage, Brazilian and Argentine beans are priced below those from the United States during their prime marketing season. Of all quality factors considered, protein content, oil content, moisture, and FM are the most important quality characteristics to most importers. In addition to its lower price, Brazilian beans are perceived to be cleaner and of higher quality (both in protein and oil contents) than beans exported by the United States. Brazilian and Argentine beans, however, are sometimes avoided by foreign buyers in part because of (1) darker color in their soyoil and reddish tint in their soymeal, and (2) a lack of

their ability to supply soybeans year-round and reliability of timely supply.

Since most soybean FM originates from the farm, policies designed to enhance the cleanliness of U.S. soybeans could address the issue of lowering FM through changes in production and harvesting practices. Policy options to address the cleanliness issue and to better meet the quality needs of domestic and foreign buyers include: (1) changing U.S. grades and standards for soybeans, (2) improving oil and protein yields through plant breeding and genetics research, (3) mandatory testing and reporting of protein and oil contents, and (4) launching an information program to enhance U.S. quality competitiveness.

Marketing soybeans with a FM content below the current level requires greater incentives than currently exist in the marketplace. Technologies to remove FM by changing production and harvesting practices are available, including herbicide use, drilled planting, and combine adjustment. However, they need to be evaluated for their cost-effectiveness more fully before their adoption.

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