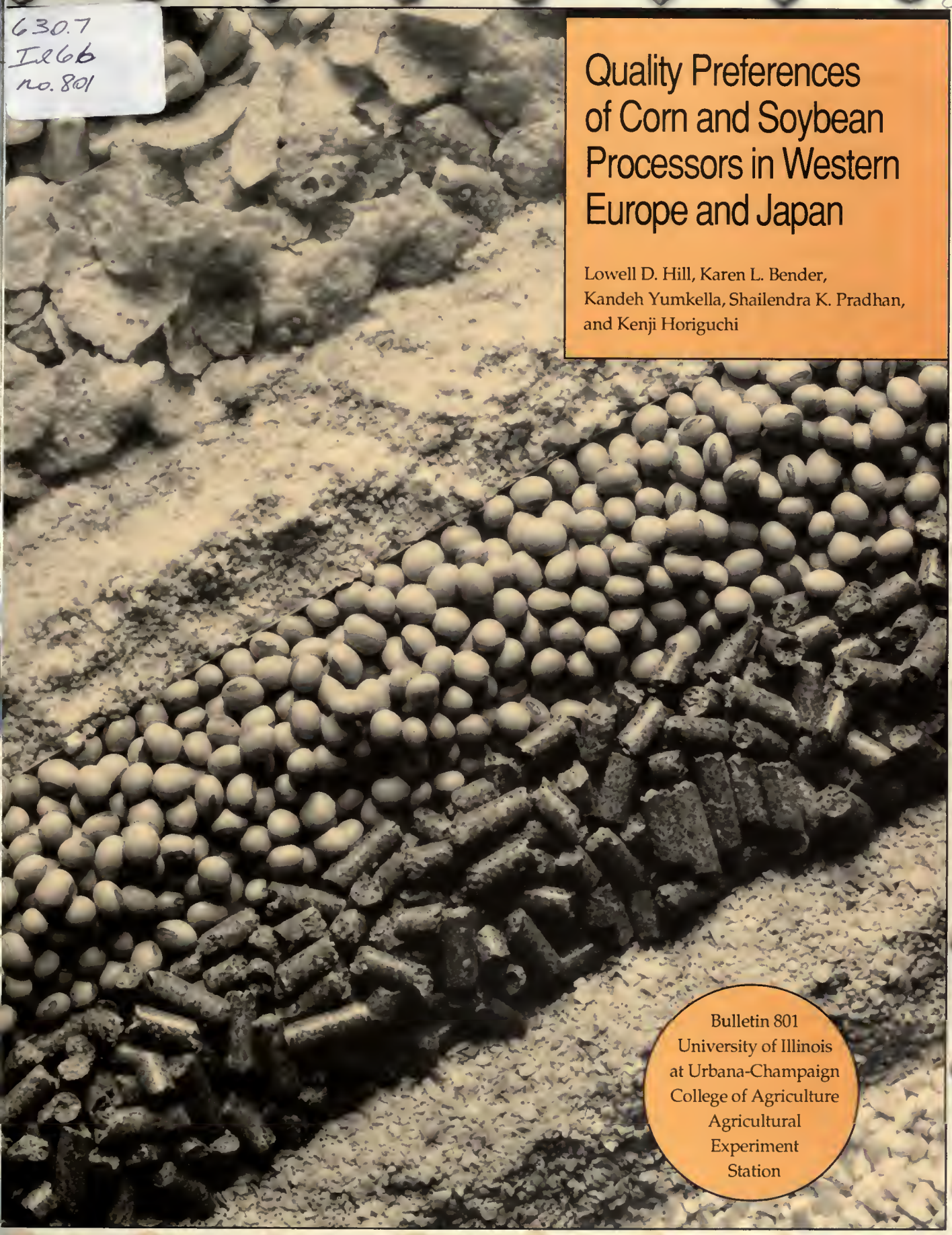
Quality Preferences of Corn and Soybean Processors in Western Europe and Japan

Lowell D. Hill, Karen L. Bender,
Kandeh Yumkella, Shailendra K. Pradhan,
and Kenji Horiguchi



Bulletin 801
University of Illinois
at Urbana-Champaign
College of Agriculture
Agricultural
Experiment
Station

Contents

Introduction 1

Soybean-Crushing Industry 2

Volume Processed 2

Origins of Imports 3

Market Channel 3

Quality Factors Included in the Contracts 3

Quality Factors Measured by the Processors 4

Full-Fat Soybean Industry 5

Volume Processed 5

Origins of Imports 6

Quality Factors Included in the Contracts 6

Quality Factors Measured by the Processors 6

Corn Wet Milling Industry 7

Volume Processed 7

Origins of Imports 7

Market Channel 8

Quality Factors Included in the Contracts 8

Quality Factors Measured by the Processors 9

Corn Dry Milling Industry 9

Volume Processed 9

Origins of Imports 10

Market Channel 10

Quality Factors Included in the Contracts 10

Quality Factors Measured by the Processors 11

Feed Manufacturing Industry 11

Volume Processed 11

Origins of Imports 12

Market Channel for Corn 12

Quality Factors Included in the Contracts 13

Quality Factors Measured by the Processors 14

Summary and Conclusions 14

Notes 17

Tables 18

Introduction

State and national legislation to increase grain exports through improved grain quality is often influenced by complaints from processors in importing countries. The questionable validity of these complaints has prompted several studies to determine the change in grade factors between origin and destination.[1, 2, 3, 4] Buyers' preferences for better quality have been suggested as one cause of shifts away from the United States as a source of corn and soybeans. However, little research exists that identifies the quality preferences of processors in other countries. Such information is needed as a basis for changing the quality of U.S. corn and soybeans in order to increase the demand for U.S. exports. U.S. producers also need to know the quality specifications desired by foreign buyers in order to meet market demands, instead of searching for markets willing to buy the qualities already produced.

Because grain is used as an input for many different products as well as for direct human consumption, the preferences of buyers are varied and complex. In addition, price and technological changes alter the optimum grain characteristics, even for a single product. Many qualities of grain are available from U.S. producers and grain handlers, and genetic changes provide even greater possibility for variation in the future. Geographical regions and weather changes introduce additional short-run diversity in quality.

A long and complex marketing chain separates U.S. producers and plant breeders from the processors in distant lands. Communication of preferences through this market channel is currently conducted via two mediums: (a) U.S. grades and standards, and (b) specification of quality characteristics in the contracts between importers and exporters. The quality requirements of distant processors are matched with available supplies in the United States, using one or both of these two techniques. However, neither of these strategies fully meets the needs of the buyers.

In the case of grades and standards, communication is limited by the number of factors currently available in the grades. The effectiveness of quality specifications in the contract is limited by the lack of agreement on the definitions of quality factors and the technology for measurement. The contractual approach to quality is also limited by the need to achieve agreement about the specifications among all the buyers who may be receiving sublots from the same vessel. In either case, price differentials are set by the market.

Not all the relationships between grain characteristics and processing yield or value are known. Different processors or end users may view the characteristics from different perspectives. However, if changes are to be made in U.S. grain grades and standards to more accurately describe real or perceived value to buyers and final users, it is essential to identify the preferences of buyers in each industry. Preferences may also differ among countries; therefore, this study of processors' preferences on two continents was undertaken to provide a basis for comparison.

Processors in Europe have been an important segment of the export demand for U.S. corn and soybeans. Despite recent reductions in European imports of corn, they continue to represent an important potential market. The quantity they will import in future years depends on the growth in total demand and on their preferences for various export origins. Although price frequently determines the choice of exporter, the industrial users of corn and soybeans in Europe are increasingly sensitive to differences in quality that might increase or decrease the value of their processed products.

Information on European processors' choice of origin, volume processed, marketing channels, and quality preferences for corn and soybeans was obtained during the summer of 1986 by a mail survey of processors in [illegible] Europe.

The study was conducted in cooperation with the Institut de Gestion Internationale Agro-Alimentaire, an educational and research institute in Cergy-Pontoise, France. In addition to the mail surveys, personal interviews were conducted with the five largest firms in each industry. The response rate, including the personal interviews, varied from 3.2 percent usable responses in the feed industry to 55.0 percent for the soybean processors (Table 1). The small response rate from the feed industry was due, in part, to the inability to differentiate on the mailing list between those feed plants using grain and those producing specialty products, such as vitamin or mineral premixes, for whom the questionnaire was not intended.

Japan currently represents the largest single market for U.S. corn and soybean exports in the world and continues to show strong growth in demand. However, the Japanese have several alternative sources from which to import both corn and soybeans, and their choice of supplier is based on quality and reliability as well as price. It is essential that the quality preferences of this important market be recognized in order to design marketing strategies to better meet the needs of these customers and to retain or increase U.S. market shares.

The study in Japan was conducted as a joint venture between the University of Illinois and the Tokyo University of Agriculture. Japanese grain processing firms were interviewed over a one-year period from the fall of 1986 to the fall of 1987.

As with the European survey, the objective of the Japanese study was to determine the quality preferences of firms in each industry as a basis for selecting factors to be included in future grades and standards. The survey also provided estimates of growth in each industry. Individual questionnaires were received from 14 feed manufacturers and 11 corn wet millers. The 27 corn dry millers provided a single composite response. The soybean crushers also provided a joint response through the Japan Oilseed Processors' Association (JOPA), speaking for its membership (Table 2). The limited number of responses in both countries preclude statistical analysis, but the consistency in preferences and unanimity in ranking quality factors on their economic importance were sufficient to provide confidence in the results presented. Although the total number of responses was small, verification of general trends by personal interviews also provided confidence in several important conclusions for each industry. In this study, each of the four major industries is described individually and comparisons are made between European and Japanese responses.

Soybean-Crushing Industry

Forty questionnaires were mailed to soybean-crushing firms in western Europe. Twenty-two of the twenty-four responses were sufficiently complete to be included in the analysis. In Japan, the Japan Oilseed Processors' Association insisted that it be allowed to provide a single consensus response to the questionnaires.

Volume Processed. The total volume processed by the twenty-two firms in Europe fluctuated from 3.9 million metric tons (mmt) to 5.0 mmt with no discernable trend between 1981 and 1986 (Table 3). These results compare closely with aggregate total crush data during this period. The processors who responded represented a range of sizes; the volume processed by individual firms in 1986 varied from 1,200 metric tons to 2.3 mmt. The average volume for 1986 was 325,139 mt. Data from JOPA showed a pattern of growth between 1980 and 1986. Soybean crush increased by 12.9 percent from 3.45 mmt in 1980 to 3.90 mmt in 1986 (Table 3). The annual rate of growth in crushing capacity peaked in 1983 with an average of 2.1 percent per year for the seven-year period.

The future growth in the volume of soybeans processed will be influenced by many economic and political factors. No attempt was made in this study to predict future utilization or im-

ports. However, respondents were asked to indicate their expectations for the industry for the next five years as a measure of optimism or pessimism by those people directly involved in the industry. Twelve respondents from Europe anticipated no change in volume. Four predicted an increase and three predicted a decrease. In the aggregate, these responses suggest no significant plans for major expansion and, therefore, no major growth in the demand for U.S. soybeans. In the case of Japan, the single response from JOPA indicated that soybean processors expected a growth rate of 1 to 2 percent per year, significantly less than during the previous five-year period.

Origins of Imports. The percentage of soybean volume imported by Europe from the United States during this period declined from a high of 87.9 percent in 1982 to only 51.2 percent in 1985 (Table 4). The market share of Argentina grew steadily during this period, while Brazil's share fluctuated from 7.4 to 23.9 percent with no discernable trend.

The response by JOPA indicated that Japanese processors imported nearly all of their soybeans from the United States during this time period. This result closely follows secondary data summarized in Table 5. In addition, secondary data indicates China had a small but increasing share of Japanese imports.

Market Channel. Five European soybean processors purchased 100 percent of their soybeans through European-based importers, and three firms purchased 100 percent through brokers. Processing firms purchasing through brokers or importers are limited in their ability to specify factors other than numerical grade in their contracts because their orders must be combined with those of other processors to assemble a uniform lot consisting of the usual 20 to 50 thousand tons per vessel.

Nearly all grain in Japan is purchased through Japanese trading companies. JOPA reported that 100 percent of the soybeans were purchased through trading companies.

Importers, in general, assembled orders from several processors and distributed the shipment among several plants after the vessel arrived in Europe. This arrangement required all of the processors to accept a uniform contract specification. Few firms would be willing to pay the cost of a hold-separation in order to specify a lower moisture or a lower foreign material content on a small consignment. Those firms buying directly from U.S. exporters were, in general, larger, included fewer specifications in their contracts, and purchased a higher proportion of their total volume from U.S. origins than firms purchasing through brokers or European importing firms. The composite responses from JOPA did not permit a similar analysis of Japanese purchases. Since Japanese crushers purchase nearly all soybeans from a single source through trading companies, it is unlikely that individual responses would have generated enough variability to show any relationship between market channel and firm size.

Quality Factors Included in the Contracts. Contracts between buyers and sellers of soybeans may include factors in addition to the numerical grade. In the European surveys and interviews, respondents were asked to identify the quality factors which they included in their contracts with each exporting country. Of the nineteen crushers in Europe who purchased soybeans from the United States, eighteen indicated they specified numerical grade, fifteen indicated moisture and eleven indicated foreign material (Table 6). Ten crushers indicated they included damage (mold) and broken beans, and eight reported including density in their contracts. Since all of the above factors except moisture are included in U.S. grades, it was assumed that respondents who reported grade factors and numerical grade were reporting the same information twice. It is possible, but unlikely, that some buyers specified a limit other than that set by the contract grade for factors such as density, damage, or broken beans. A few respondents included other factors not in

U.S. grades in their contracts with U.S. exporters. These included germination (one respondent), oil (two respondents), protein (one respondent), and fiber (one respondent).

All soybean crushers purchasing soybeans from European origins included moisture and foreign material in their contracts. Two of the three respondents reported that they specified a numerical grade (Europe does not have numerical grades for soybeans), damage, and broken beans in their contracts. Only one respondent reported that oil content was included in the contracts. These responses may have referred to purchases of U.S. beans from other European firms because none of these three respondents reported purchasing soybeans grown in Europe.

Of the fourteen processors who purchased soybeans from Argentina, ten included moisture and oil content, nine included foreign material, and five included mold damage in their contracts. Three respondents included the percentage of broken beans in their contracts with Argentina.

Of the ten processors reporting purchases of beans from Brazil, eight indicated they included moisture, and seven included foreign material and oil content in their contracts with Brazil. Five processors included mold damage and four included the percentage of broken beans in their Brazilian contracts.

There are many differences in contracts with the various countries of origin. Purchases from U.S. exporters were most frequently based on numerical grade and moisture. Moisture was also the most frequent factor specified in contracts with other countries. Oil content was included in the majority of contracts with Brazil and Argentina, but only two respondents included oil in their contract with the United States. Only one respondent relied on the fair average quality (FAQ) contract; no individual factors were specified in that contract.

It is evident from these responses that European processors were concerned about most of the physical properties of soybeans, especially moisture content, foreign material, mold damage, and broken beans. Although several chemical properties were mentioned by the respondents, the only factor included in contracts by a majority of the firms was oil content and then only with Argentina and Brazil.

The Japanese processors, like their European counterparts, placed more emphasis on the physical properties than the chemical properties of soybeans. In addition to the four physical properties listed by the Europeans, the Japanese also specified density. Japanese processors reported that no chemical factors were specified in contracts. Not enough soybeans were purchased from Argentina and Brazil to permit a comparison of contract terms.

Quality Factors Measured by the Processors. While information on many factors may be requested from sellers, those selected are usually automatically included in standard contracts and export grades. A better measure of the relative importance of the various chemical and physical properties is the frequency with which firms measured quality characteristics in their plant. It was assumed that plant managers conducted only those tests that provided information more valuable than the cost of testing. Using this criterion, the most important factors for European soybean processors are moisture, oil, and foreign material (Figure 1). More than 80 percent of the respondents checked the level of these factors on every delivery. Protein ranked fourth in importance with 79 percent of the respondents testing for it every delivery. The level of damage and protein was tested by two-thirds of the respondents. Blanks left by the respondents were not assumed to be an implicit "never tested," although that may have been their intention. However, 21.1 percent and 5.3 percent of the respondents checked "seldom" or "never," respectively, for the factor of density. The information least desired (i.e., density) is provided automatically in U.S. grades but not in the grades of Argentina and Brazil. Oil content (not

included in grades of any exporting country) was second only to moisture in its importance to processors. The Japanese processors indicated that all physical and chemical properties were measured in every delivery.

Full-Fat Soybean Industry

The processing of full-fat soybeans (FFSB) is a subsector of the soybean processing industry in the European market with some unique characteristics. Six of twelve known FFSB processors in the EC-10 responded to the questionnaires. The small sample is inadequate for statistical analyses, but the trends suggest some tentative conclusions.[5]

Of the six respondents processing FFSB in 1986, only two were in business in 1980. Two of the six firms entered the industry in 1981 and two more in 1983. The quantity of soybeans processed increased rapidly through 1983; however, in 1984, the high price of soybeans relative to alternative ingredients, especially soybean meal, caused a decrease in the use of FFSB (Table 7). Although soybean imports to the EC for all purposes declined in 1984 and 1986, the tonnage of FFSB processed remained almost constant between 1984 and 1985. The 1986 tonnage rose as soybean prices dropped relative to prices of soybean meal.

Full-fat soybeans are produced by roasting or extruding whole soybeans to kill the trypsin inhibitor present in raw soybeans. The roasted or extruded FFSB are used mainly in swine and poultry rations where they provide both high quality protein and energy. The protein and energy available in FFSB allow the processors to replace a portion of feed grains that supply energy.

Volume Processed. Estimated use of soybeans by FFSB processing firms exceeded six percent of the soybeans imported by the EC-10 in 1986. In the United Kingdom, nearly 33 percent

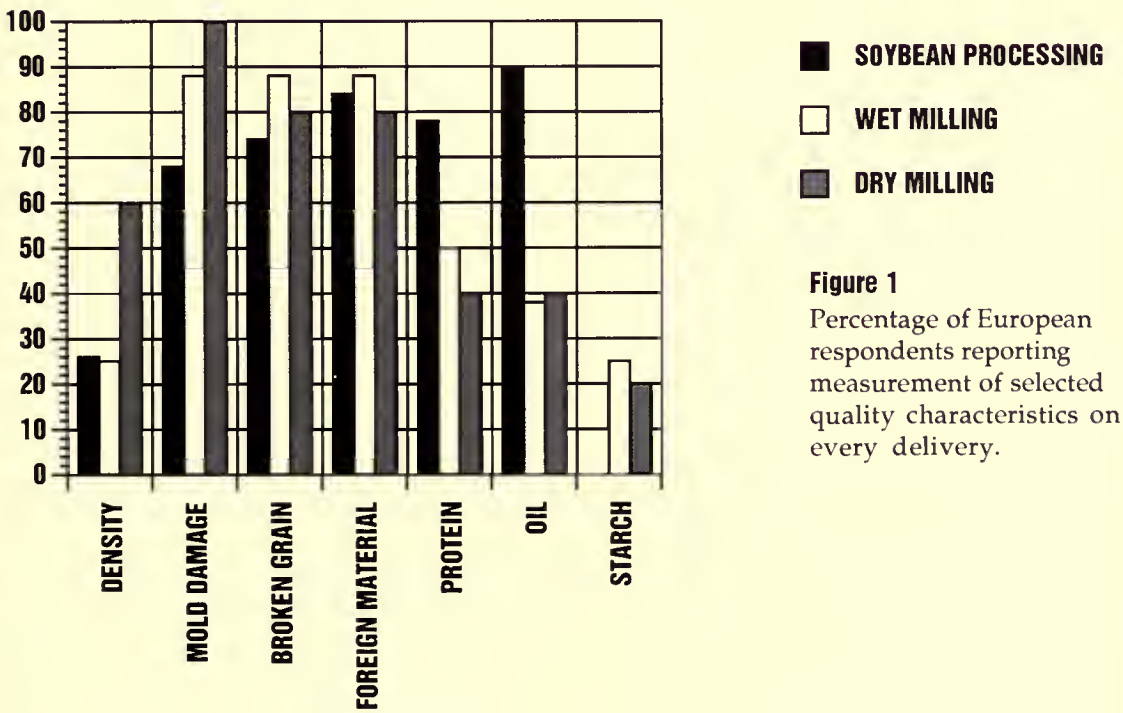


Figure 1
Percentage of European respondents reporting measurement of selected quality characteristics on every delivery.

of 1986 soybean imports went to FFSB processors. While processing of FFSB increased 48 percent between 1985 and 1986, EC imports of soybeans for all uses dropped slightly, despite a fall in soybean prices. The average production volume per responding firm in the EC-10 in 1986 was 53,000 metric tons. Full-fat processors thus had a small, but important part in keeping EC soybean imports from falling further. The importance of the FFSB industry has been recognized by others. An increase in EC soybean imports in late 1986, despite an increase in domestic oilseed production, was noted by the editor of *Oil World,* who suggested that one explanation for this occurrence was "the pick-up in usage of whole, toasted soybeans in mixed feeds."[6]

Origins of Imports. The importance of the FFSB industry to U.S. farmers lies not only in the quantity of soybeans imported by the EC, but also in the country of origin. In 1982, a high of 92 percent of the soybeans used by the FFSB companies surveyed was imported from the United States (Table 8). That share fell to 87.6 percent in 1983, 79.2 percent in 1984, and 76.4 percent in 1985. The loss of market share in total EC imports followed a similar pattern (Table 4). The proportion of volume imported from U.S. sources was generally higher in the FFSB industry than in the EC soybean oil and meal industry. The percentage of soybeans imported from Brazil and Argentina for FFSB processing offsets the decline in imports from the United States, increasing from 6 percent in 1982 to 22 percent in 1985 (Table 8). This reversed the situation from the early 1980s, when the increasing U.S. market share offset declines in imports from Brazil and Argentina.

Quality Factors Included in the Contracts. FFSB processors choose the origin of their soybeans according to quality and price. The processing of feed from whole soybeans requires that the nutritional values of the soybeans meet minimum specifications. This will assure the quality of the complete feed. The percentage of oil, protein, moisture, and foreign material all influence the nutritional value of the FFSB used in swine and poultry rations.In addition to the numerical grade specified in contracts with the United States, four of the six FFSB companies responding to the survey included moisture content, and two included foreign material, damage, and density (Table 9). Only one company reported that protein and oil content were included in its contracts with the United States, and only one firm included oil content in contracts with Argentina.

Quality Factors Measured by the Processors. Sixty-seven percent of the firms measured moisture, oil, and protein content of every shipment received. Only thirty-three percent of the firms indicated that they measured the numerical grade, density, and foreign material content of every delivery. This suggests that moisture, protein, and oil content are the most important qualities to FFSB processors, although moisture content is the only characteristic (in addition to numerical grade) that is routinely included in contracts.

The physical properties of soybeans that are important for FFSB processing are similar to the desired physical properties of soybeans purchased for crushing. The main divergence between the FFSB processors and the oil crushing industry was that 83 percent of the crushers indicated measuring foreign material in the soybeans on every delivery, while only 33 percent of the responding FFSB firms indicated doing so. It appears that soybean crushers and FFSB processors demand nearly the same quality characteristics in their soybeans, but that low foreign material is more important to crushers than to the FFSB industry. This is a logical difference because foreign material at destination consists largely of broken beans and edible plant material. This foreign material usually provides energy in feed rations, but it may often create problems in production of oil. The foreign material caused few problems for FFSB firms, unless it reduced the oil and protein content of the final product.

Corn Wet Milling Industry

Twenty-one questionnaires were mailed to firms in the wet milling industry in Europe whose primary products were starch and corn sweeteners. Nine of the ten respondents provided sufficient information for analysis. Eleven questionnaires were received from wet millers in Japan; these included all major processing firms.

Volume Processed. The total volume of corn processed by the nine respondents in Europe increased steadily from 1.65 mmt in 1981 to 2.99 mmt in 1985, then declined to 2.08 mmt in 1986 (Table 10). The quantity of corn processed by individual firms varied from 40,000 mt to 440,000 mt in 1986. The average volume processed in 1986 was 260,375 mt.

The total volume of corn processed by the wet milling industry in Europe is influenced by many economic and political factors. The major growth between 1981 and 1985 was stimulated by strong demand for starch and corn sweeteners, aided by national policies encouraging the use of corn for starch. In addition to processing a larger percentage of domestic corn, European millers have also shifted from corn to wheat as a feed stock for their production of starch. This shift was largely the result of changes in agricultural policies.[7]

When respondents were asked to identify their expectations about the volume of corn processed during the next five years, six of the nine anticipated no change in total volume, two predicted an average increase of eight percent, and one did not respond. Of the two respondents predicting growth, one indicated plans for plant expansion and the other thought the growth would be industrywide. This indicates that, in the aggregate, European wet milling firms do not have plans for major expansion, and there will be little or no growth in corn import demand from the United States or other origins for use in wet milling. Several respondents who predicted no change in the future commented that any growth in demand for starch processing would be met by wheat rather than corn.

The quantity of corn processed by corn wet millers in Japan increased steadily, from 1.46 mmt in 1981 to 2.47 mmt in 1985 (Table 11). In 1986, the trend reversed showing a slight decline to 2.33 mmt, a 5.9 percent reduction from the previous year. The average annual quantity of corn processed per firm was 211,363 mt in 1986, ranging from 132,500 mt in 1981 to 224,600 mt in 1985. There was an overall increase in the volume of corn processed in the wet milling industry, as well as an increase in the average capacity per firm.

All but three of the corn wet millers anticipated an increase in the quantity of corn processed in the Japanese wet milling industry, projecting an average annual growth of about 2.9 percent in the quantity of corn processed. The processors indicated that this growth will depend on growth in the Japanese economy, population growth, the extent to which processing firms diversify their products, and the extent to which starch is imported into Japan from other countries.

Origins of Imports. The United States has lost volume and market share in the European wet milling industries (Table 10). The percentage of European corn imports coming from the United States decreased from a high of 81.5 percent in 1981 to 13.8 percent in 1986. The share from European sources showed a steady growth from 17.7 percent in 1981 to 86.2 percent in 1986 — nearly a five-fold increase within the six-year period. The market share from Argentina fluctuated from a low of 0.4 percent to a high of 3.3 percent during this time period.

The survey data for corn wet millers in Japan show that the major sources of corn imports are the United States, South Africa, and China. These three countries accounted for over 90 percent of total corn imports from 1981 to 1984 (Table 11), with South Africa and the United States as the primary sources. The U.S. share

of Japanese corn imports increased from an all-time low of 12.3 percent in 1981 to a high of 88 percent in 1984, followed by sharp declines in 1985 and 1986. The South African share changed inversely with the U.S. share, indicating an almost direct substitution between the two countries. The South African share was in part determined by the availability of imports during South Africa's drought periods. Corn imports from China accounted for less than one percent of total import volume until 1984, when China's share of the corn imports increased to 6.0 percent. In 1985, this share jumped to 21.1 percent, coinciding with China's large increase in domestic production. In 1986 China's share declined to 13.6 percent. Corn imports from Argentina were minimal.

Market Channel. Three European wet milling firms reported purchasing 100 percent of their corn through European importers, and one firm reported purchasing 95 percent of their corn through European importers. One respondent purchased 86 percent of the corn directly from U.S.-based exporters, and four firms did not specify the methods of purchase. In Japan, all but one firm in the wet milling industry reported purchasing 100 percent through Japanese trading companies. The one exception purchased 85 percent of its grain from trading companies and 15 percent from U.S. exporters.

Quality Factors Included in the Contracts. All of the seven European wet milling firms purchasing corn from the United States reported that their contracts specified numerical grade (Table 12). Six of the seven reported that moisture was also specified. The major grade factors such as damage, broken corn, and foreign material were also identified by three respondents. It can be assumed that this identification was simply an elaboration because these factors are automatically part of the numerical grades. Two firms reported using contracts specifying chemical factors that were not a part of U.S. grades.

Five of the seven firms purchasing corn from Europe included moisture in their contracts, and four reported that they also specified levels of mold damage, broken corn and foreign material in their contracts. Two firms reported including germination in their contracts with European sellers. One firm reported that the country of origin was the only quality control stipulation included in its contracts.

Only two respondents reported purchasing corn from Argentina. One firm specified moisture content and germination, the other firm relied on the London Grain and Feed Trade Association's FAQ contract to assure acceptable quality.

Only the U.S. and European origins had a sufficient number of responses to permit a comparison of origins with differences in factors in the contract. These responses showed that numerical grade was the basis for quality specification in purchases from the United States. European contracts relied primarily on specification of individual factors, which were often the same as those included in U.S. grades. The exception was density (test weight), which is a grade-determining factor in U.S. grades, but was not included in the contracts with any other countries supplying corn.

Eight wet millers in Japan included moisture content in their contracts when purchasing corn from the United States (Table 13). Five out of eleven corn wet millers indicated that they included numerical grade, damage, broken corn and foreign material in their contracts. Only one firm specified density in its contract. Four chemical factors were specified by four corn wet millers, namely, starch, protein, fiber, and oil. The type and frequency of quality factors specified in South African contracts were generally similar to those in the U.S. contracts, except that there were slightly more millers specifying numerical grade and foreign material in the South African contracts.

Contracts for China included only four factors, namely, moisture content, damage by mold, broken corn and foreign material. Only two respondents specified moisture, and one re-

spondent specified the other three characteristics.

Quality Factors Measured by the Processors. More than 85 percent of the European firms responding to the questionnaire measured moisture, damage, broken corn and foreign material on every delivery (Figure 1). Thirty-seven percent of the respondents checked numerical grade, and 50 percent checked protein content on every delivery. Twenty-five percent of the respondents reported testing for density on a regular basis, and one firm noted that it never analyzed samples for density. Although starch and oil have the highest value of the products from the wet milling industry, few firms reported testing for these properties. The lack of variability in starch and oil contents may be a partial explanation.

Wet millers in Japan appeared to test more frequently for a larger number of quality characteristics than European millers (Figure 2). Moisture was tested on every delivery by 100 percent of the respondents; foreign material, starch, protein, and oil content were tested by 80 percent of the respondents; broken corn by 70 percent; mold damage and fiber by 60 percent; and density by 40 percent of the corn wet millers responding to the survey.

Corn Dry Milling Industry

Questionnaires were mailed to seventeen firms identified as the dry milling industry in Europe. Of the six responses, five provided sufficient information for analysis. Japan dry millers provided only one joint, unanimous response for the entire industry, assembled by the Japan Corn Grits Association (JCGA).

Volume Processed. The total volume of corn processed by the five respondents in Europe increased steadily from 280,000 mt in 1981 to 449,000 mt in 1986 (Table 14). The quantity of corn processed in 1986 by individual mills

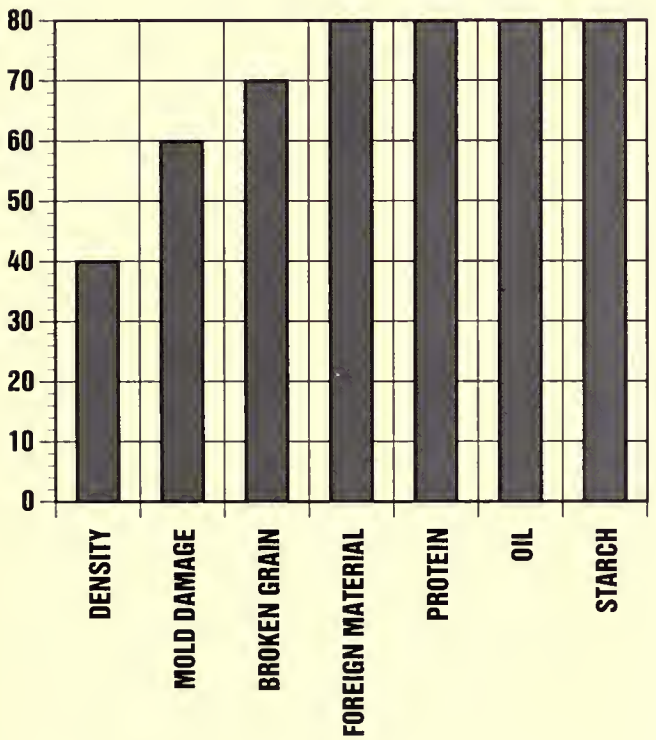


Figure 2
Percentage of Japanese respondents reporting measurement of selected quality characteristics on every delivery.

varied from 15,000 mt to 155,000 mt, with an average size of 89,800 mt.

In response to the question of future growth in the volume of corn processed in Western Europe, two respondents anticipated no change, three respondents anticipated an increase, one indicated expectations of a 2 percent increase in the next five years, and another anticipated a growth of 20 percent. On the average, this suggests a slight increase in demand for corn by European dry milling industries.

In Japan, the quantity of corn used in the dry milling subsector ranged from a low of 267,000 mt in 1982 to a high of 330,000 mt in 1986 (Table 15). From 1980 to 1986, corn use in Japan increased by 11.5 percent. The largest annual increase in usage occurred in the 1984 to 1985 period. The average total quantity processed from 1980 to 1986 was 303,100 mt. Without questionnaires from individual firms, no further analysis of size distribution was possible.

In Japan, the association of corn dry millers reporting on behalf of their membership anticipated a 3 to 4 percent annual growth in the quantity of corn used by their industry over the next five years.

Origins of Imports. The percentage of corn imported by Europe from the United States during the study period fluctuated from approximately 6.8 percent in 1982 to 21.8 percent in 1984, with no discernable trend (Table 14). The percentage of corn purchased from South Africa exhibited a significant decline from a high of 47.5 percent in 1981 to only 4.2 percent in 1985 and zero in 1986. In contrast, Argentina's market share increased dramatically from zero percent in 1981 through 1984 to 29.9 percent in 1985 and 20.7 percent in 1986. Purchases from European sources showed a significant increase from zero in 1981 to 43.1 percent in 1985, followed by a decline in 1986. In general, the declining U.S. share was offset by increases from Europe and, in recent years, from Argentina. The preference of European dry millers for hard endosperm corn is evident in the higher proportion of their purchases from Argentina and Europe where flint varieties are grown.

There was no consistent pattern in the annual volume of corn purchased by Japanese dry millers from various sources (Table 15). Japanese corn dry millers purchased corn mainly from the United States and South Africa. The percentage of corn purchased from the United States was above 55 percent for all years except 1982, when it dropped to 40 percent. The South African market share was below 40 percent for all years (reaching a low of 5 percent in 1984 and 1985) except 1982, when their share reached 60 percent. China's share of the market was zero from 1980 to 1983, increasing to 5 percent in 1984, 30 percent in 1985, and 20 percent in 1986. No purchases were made from Argentina except in 1984, when it accounted for 5 percent of the market.

Market Channel. Dry millers in Europe purchased corn primarily through European-based brokers. However, two firms indicated purchasing their entire volume directly from U.S. exporters.

In Japan, all but two of the dry milling firms purchased 100 percent of their corn from Japanese trading companies. One firm reported purchasing 75 percent of its total volume directly from U.S. exporters. A second firm reported purchasing 5 percent from U.S. exporters.

Quality Factors Included in the Contracts. All three of the European mills that purchased corn from the United States specified numerical grade and moisture content in their contract specifications (Table 16). One respondent included several factors generally associated with the yield of flaking grits, such as hardness, stress cracks, and variety. All three of the mills who purchased corn from Europe included moisture in their contracts. Two included the factors of mold damage, broken corn and foreign material. One reported that numerical

grade was included in the contract, although Europe does not have numerical grades for corn in domestic trade. Purchases from Argentina were reported by only two firms. Both indicated the use of FAQ contracts with no other factors identified. The one firm purchasing corn from South Africa reported the use of numerical grade as the only quality factor in the contract.

The Japan Corn Grits Association indicated that its members specified numerical grade, moisture content, mold damage, broken grain and foreign materials in U.S. contracts. Contracts for China, South Africa, and Argentina included all of these factors, except mold damage.

Quality Factors Measured by the Processors. One-hundred percent of the respondents in Europe answering the question on factors measured indicated that they measured moisture and mold damage on every delivery to their plant (Figure 1). Eighty percent reported that they checked for broken corn and foreign material in every delivery. Sixty percent checked for density in every delivery, and forty percent of the respondents indicated they measured stress cracks, protein content, and oil content, and conducted floater tests on every delivery. Twenty percent measured hardness and flintiness on every delivery. The contrast with the responses from the wet milling industry indicates the relatively greater importance of density and hardness in the dry milling industry.

In Japan, the JCGA reported that it measured every factor listed in the questionnaire on every delivery.

Feed Manufacturing Industry

Surveys were sent to a random sample of 810 firms identified as feed-related. At the time of the mailing, information was not available that would distinguish between feed-related firms purchasing corn and those not purchasing corn. Because most feed-related firms were not purchasing corn, a low response rate was expected. Of the thirty-six returned responses, twenty-six were sufficiently complete to be included in the analysis. The original Japanese mailing list identified 67 firms in the feed industry. Fourteen firms returned completed questionnaires.

Volume Processed. Data were obtained from the European respondents on the volumes of corn, corn gluten meal, and soybean meal processed domestically. The volume of corn processed varied from 1.37 mmt in 1981 to 2.25 mmt in 1986, reflecting a steady growth (Table 17). The size of the firm varied widely with the 1986 annual volume of individual firms ranging from 150 mt to 1,000 mmt. The total volume of soybean meal processed by the respondents increased steadily from 1.04 mmt in 1981 to 2.01 mmt in 1986 (Table 18). Its growth was slowed, in part, by the availability of corn gluten feed. The total volume of corn gluten meal processed by the respondents increased dramatically from 270,000 mt in 1981 to almost 1.5 mmt in 1986, reflecting the increased supply of corn gluten meal as a by-product of U.S. wet milling industries (Table 19). In the absence of import restrictions, European feed firms substituted corn gluten meal for other feed ingredients.

When asked their expectations for future growth of the feed industry, five mills indicated that they did not anticipate any change in volume, five respondents anticipated an increase, and nine predicted a decrease. Seven firms did not respond to the question. In the aggregate, this suggests no major expansion in the European feed industry and the possibility of a decline in the total volume of corn purchased.

The fourteen Japanese feed manufacturers who responded to the survey did not provide data on quantities processed. However, estimates by industry experts in Japan suggested that approximately 24 million metric tons of composite and mixed feed were produced in 1983. Annual volume in 1983 ranged from 100,000 mt to

8.96 mmt, with an average of 358,209 mt for the total of 67 surveyed firms in the industry. When asked to indicate their expectations of industry growth for the next five years, nine firms indicated an expected increase in volume of corn purchased varying from 1.2 percent to 30 percent. Two respondents expected a decrease of 1 percent and 5 percent, respectively. One respondent anticipated no change; two did not respond to the question. Combining the diverse answers indicates that there will be continued growth in demand for U.S. feed grains. Respondents also provided an explanation for their answers. Those predicting expansion in the industry attributed the growth to increased consumption of meat, growth of the livestock industries, and an increase in the use of corn in manufactured feeds. One respondent predicted a decrease in the demand for feed and attributed this to increased imports of livestock products as demand increases. The other respondent who predicted a decrease in corn use related the decline to a possible increase in the price of corn.

Origins of Imports. The percentage of corn volume imported from the United States by the European feed manufacturing firms declined continuously from 18.1 percent in 1981 to about 10 percent in 1986 (Table 17). The Argentine share showed steady growth from 0.4 percent in 1981 to 4.8 percent in 1985. However, it dropped to only 0.2 percent in 1986. The percent of corn supplied domestically (primarily from France) fluctuated around the 80 percent level until 1986 when it jumped to a record high of 88.3 percent.

The U.S. share of the European soybean meal import market was only 8.1 percent at its peak in 1983 and had fallen to only 5.4 percent in 1986. Of more significance was the gradual decline in the percentage of soybean meal purchased domestically (from 42.6 percent in 1981 to 32.7 percent in 1986) and from Brazil (28.7 percent in 1981 to 24.1 percent in 1985). Argentina replaced imports from both countries with an increase in its market share from 20.9 percent in 1981 to 30.9 percent in 1985. In 1986, however, Brazil's market share increased dramatically to 38.5 percent, while Argentina's market share dropped to 22.1 percent.

The percentage of European corn gluten meal purchases imported from the United States increased dramatically during this period from a low of 38.9 percent in 1981 to 83.7 percent in 1986 (Table 19). In contrast, the percentage of corn gluten meal purchased from domestic sources in Europe declined from 60.3 percent in 1981 to only 16.0 percent in 1986. Similarly, the percentage imported from countries other than Europe and the United States declined from 1.1 percent in 1981 to 0.3 percent in 1986. This came not as a result of major decreases in the volume purchased from other sources, but as a result of the dramatic increase from U.S. sources.

Corn purchases by Japanese feed manufacturers primarily originated in the United States. Over 90 percent of the feed manufacturers reported purchasing 60 percent or more of their corn requirements from the United States. Some corn was also purchased from China and Argentina in 1985 and 1986, but there was no indication of a trend toward these other countries. Thirteen of the fourteen feed manufacturers who responded to the questionnaire purchased between 80 and 100 percent of their soybean meal and corn gluten meal requirements from Japanese crushers between 1982 and 1986. The remaining 20 percent was purchased from the United States. The proportion purchased from the United States increased slightly in 1985 and 1986.

Market Channel for Corn. Seven European feed manufacturers purchased 100 percent of their corn through European importers, three firms purchased their entire volume through brokers, and only one firm purchased 100 percent of its corn through a U.S.-based exporter.

In the case of Japan, the majority of grain was purchased through Japanese Trading Companies (JTC). Ten firms purchased grain exclu-

sively through JTC; one purchased 95 percent through JTC and 5 percent from U.S. exporting firms. Only one firm indicated that 75 percent of its raw grain procurement was handled by U.S.-based firms. Two firms did not respond to the question.

Quality Factors Included in the Contracts. Of the seven European feed manufacturers who purchased corn from the United States, six firms included broken corn, five included numerical grade and protein, and four firms reported moisture, mold damage, foreign material, and fiber content as specific factors in their contracts (Table 20). Only two feed manufacturers included density in their contracts. Information about many of the contractual factors listed by the respondents is automatically available as part of the numerical grade. These responses indicate the importance of controlling factors such as damage and foreign material, but it is unlikely that the contracts include limits on these factors outside the official USDA grade limits.

Of the thirteen feed manufacturers that purchased corn from Europe, eleven included numerical grade, ten included mold damage and broken corn, eight included protein, and seven included density and carbohydrates in their contracts. All three of the feed manufacturers who purchased corn from Argentina included foreign material, protein, and carbohydrates in their contracts, while all three of the feed manufacturers who purchased corn from South Africa included only carbohydrates in their contracts.

Of the eleven firms that purchased soybean meal from both the United States and Europe, all firms included protein, and nine firms included moisture and fiber in their contracts (Table 21). All of the five feed manufacturers who purchased soybean meal from Argentina included protein, while four included moisture and fiber in their contracts. Thus, moisture, protein, and fiber content are standard factors in European purchase contracts for soybean meal, regardless of the country of origin.

All of the nine feed manufacturers that purchased corn gluten meal from the United States included protein in their contracts, while seven included moisture and six included fiber content (Table 22). Only two mills included carbohydrates in their contracts for corn gluten feed. Of the six firms that purchased corn gluten meal from Europe, all included protein, five included fiber content, and three included moisture in their contracts. Only two feed manufacturers purchased corn gluten meal from Argentina, and only one from South Africa. All three included protein and fiber content in their contracts. The corn gluten contract appeared to be fairly consistent regardless of the country of origin, with protein and fiber content the primary factors of concern.

Of the fourteen Japanese feed manufacturers that purchased corn from the United States, thirteen included numerical grade, eleven included moisture content, and eight included mold damage and broken corn in their contracts (Table 23). Six firms included density and foreign material in their contracts with the United States. As only three firms included protein content, and only two included carbohydrates and fiber in their contracts, the emphasis of processors was on physical information available from the numerical grade. One firm included ash content in its contracts with the United States, China, and Argentina.

Of the fourteen Japanese feed manufacturing firms that purchased corn from China, ten included moisture, seven included mold damage and foreign material, six included broken corn, and five included numerical grade. Again, the emphasis of purchasing firms was on physical characteristics, as only three firms included protein content in their contracts with China, and only two firms included fiber. No Japanese firm included density in its contracts with China.

Thirteen Japanese feed manufacturing firms responded as having purchased corn from Argentina. Eight respondents included moisture, seven included numerical grade, six included damage by mold, five included broken corn,

and four included foreign material in their contracts with Argentina. Two respondents included protein and fiber content in their contracts as well, while no firm included density in its contracts.

Only three Japanese feed manufacturing firms responded as having purchased corn from South Africa. All firms included numerical grade and moisture in their contracts, and two firms included damage by mold, broken corn, and foreign material. Again, no firm included density in its contracts with South Africa.

As with Europe, the Japanese feed manufacturers frequently included all physical characteristics except density in their contracts with exporting countries. In contracts with the United States, density information was automatically provided if they indicated a numerical grade. Chemical characteristics were included in contracts less frequently by the Japanese than by the Europeans.

Of the five Japanese firms that purchased soybean meal from the United States, four included protein and one included moisture content in their contracts (Table 24).

Two firms purchased soybean meal from China; of these firms, one included moisture in its contract and one included protein.

Of the three Japanese firms purchasing soybean meal domestically, two included fat and three included ash in their contracts.

Western European feed manufacturers included protein in all of their soybean meal contracts, regardless of country of origin. Japanese feed manufacturers, however, did not always include protein in their contracts with foreign suppliers and never included protein in their domestic contracts.

The United States was the only source of corn gluten meal for use in feed manufacturing as reported by ten Japanese firms. Of these ten, six included protein, four included moisture, and one included carotenoid color in their contracts. The primary difference between the European and Japanese contracts was the Europeans' frequent inclusion of fiber in their contracts.

Quality Factors Measured by the Processors. The factors most frequently measured in every delivery of corn by European feed manufacturers are moisture, protein, broken corn and foreign material. At least 50 percent of the respondents tested for all of these factors in every delivery (Table 25). Few feed manufacturers measured broken corn after every delivery because most of the feed industry grinds corn during processing. Over 78 percent of the respondents checked for moisture, fiber, and protein in every delivery when purchasing corn gluten meal, and more than 56 percent of the respondents checked for these factors in every delivery of soybean meal. In addition, half of the respondents measured carbohydrates in every delivery of corn gluten meal. Trypsin inhibitor was the only additional characteristic identified by the respondents with 30 percent testing for it on every delivery of soybean meal.

Japanese feed manufacturers were concerned primarily with the levels of moisture and protein content in their raw material. Fifty-seven percent of the feed manufacturers tested for protein on every delivery of corn, and sixty-four percent tested for moisture (Table 26). The corresponding figures for soybean meal were 57 percent for protein and 50 percent for moisture. For corn gluten meal, 69 percent tested for protein while 61 percent tested for moisture on every delivery.

Summary and Conclusions

For the European Community, the period from 1981 to 1985 was one of general growth in the volume of corn and soybeans processed for the full fat soybean, corn wet milling, corn dry milling, and feed manufacturing industries. In 1986, the full fat soybean, dry milling, and feed manufacturing industries continued to post increases in processing volumes. There was no discernable trend for soybean processing vol-

umes. Respondents' expectations suggested no significant growth in imports of corn and soybeans for most of these industries over the next five years. A possibility of a slight increase in demand exists in the corn dry milling industry, and the responses from the full fat soybean industry were mixed: three responses indicated no change in processing volume was expected, while two respondents predicted as much as a 15 percent increase in processing volume.

In Japan, by comparison, the volume of soybeans and corn used by the soybean processing industry and the corn dry milling industry grew through the entire period from 1981 to 1986. Corn volume processed in the corn wet milling industry paralleled that of the EC corn wet milling industry, showing gains in 1981 through 1985, then declining in 1986. No time-series volume information was provided by the Japanese feed manufacturing industry. Future expectations were much more positive than those of the European firms, with continued gains in volume expected in the soybean processing, wet and dry milling, and feed manufacturing industries in the next five years.

European imports of corn, soybeans, and feed ingredients from the United States declined for all industries except the feed manufacturing industry, which dramatically increased imports of U.S. corn gluten meal between 1981 and 1986. This increase reflects additional supplies of corn gluten meal available from the United States, following growth in the corn wet milling industry, as well as reflecting the nontariff status of corn gluten meal imports into the European Community. In industries using corn as a feedstock, loss of market share in the United States was primarily due to Europe's increasing dependency on domestic sources. In both soybean and full fat soybean processing industries, however, the decline in imports from the United States was offset by increases in imports from both Brazil and Argentina. Even the imports of soybean meal from Brazil and Argentina increased in total during this period, though the overall increase was not large and displaced mostly soybean meal purchased from domestic sources.

The U.S. share of Japanese imports of soybeans did not change as dramatically as the U.S. share of EC imports, though the volume of corn imports from the United States did vary considerably. During the 1981 to 1986 period, nearly all of Japan's soybean imports originated in the U.S., with only a slight increase in imports from China. Corn imports for the wet and dry milling industries primarily originated in the United States and South Africa, with the amount purchased from one country inversely related to the amount purchased from the other country. China began exporting corn to Japan as well in the later years. Byproducts used in the Japanese feed manufacturing industry were produced by domestic processing firms, and purchases from the United States were minimal.

The market channel makes factor specification within a contract difficult and expensive if those factors are not included in the grades. This was indicated in responses from the European processors who are buying through importers or brokers. The complexity of buying sublots with unique characteristics generally limits this market channel to the use of numerical grade.

Some of the characteristics identified as important indicators of value by respondents in this survey were important for all industries; others were unique to one of the four industries studied and differed among countries. Moisture content, damage, and foreign material were identified as important characteristics regardless of the intended purpose of the corn and soybeans. As determined by measurement of selected quality characteristics on every delivery, chemical composition of the corn was more important to feed manufacturers than to dry millers. The dry milling industry indicated a greater concern about density and the extent to which the kernels would remain intact during handling. Oil and protein content were important to all soybean processors.

While several processors specified factors in addition to numerical grade when buying from U.S. origins, individual factor specification was used more frequently in contracts with Argentina, Brazil, and Europe. This demonstrates confidence in U.S. numerical grades. The frequency with which buyers use numerical grades reflects the increased efficiency of communication and simplicity in contracts based on a single number. However, the specification of additional quality characteristics, especially by wet and dry corn millers, suggests that numerical grade alone does not provide adequate information on which to estimate value related to differences in quality. The characteristics measured and identified as important to the various processors were consistent with research that has identified relationships between yield and value of products from corn and soybeans in the different industries.[8, 9, 10]

Japanese processors tended to exhibit greater uniformity among firms in their contracts and factors measured at the plant than respondents from Europe. The almost exclusive reliance on Japanese trading companies as the source of imports provides a partial explanation of the differences between countries.

Japan's firms in the corn milling industries relied almost exclusively on numerical grades in their contracts, while European processors frequently specified factors separately, especially in non-U.S. purchases. However, Japan's firms measured a greater number of quality-related characteristics at their plant than did European firms.

The purposes of grades and standards are to describe, as accurately and objectively as possible, the information needed by buyers and sellers to arrive at a price that reflects true value. Information is obtained only with the expenditure of time and money. Therefore, the information provided by grades must be evaluated in the context of its cost versus its value. Although this study does not provide a cost-benefit analysis of the alternatives, it does identify that many processors are making additional quality measurements at their plants at their own expense. This information is obtained, however, only after the grain has been delivered and no choice is left to processors in terms of selection or alternative pricing. Such information is needed *prior* to selecting qualities and establishing price so as to direct each different quality into its potentially highest valued use.

Survey results primarily reflect opinions. However, when these opinions are consistent with research results, they warrant careful consideration and the necessary analysis to determine the cost-benefit ratio of providing additional information at the point of origin for corn and soybeans.

Notes

1. Hill, Lowell D., Marvin R. Paulsen, and Margaret Early. *Corn Quality: Changes During Export* (Special Publication 58). Agricultural Experiment Station, College of Agriculture, University of Illinois at Urbana-Champaign, 1979.
2. Hill, Lowell D., Marvin R. Paulsen, Timothy L. Mounts, A.J. Heakin, and G.R. List. *Changes in Quality of Corn and Soybeans Between United States and England* (Special Publication 63). Agricultural Experiment Station, College of Agriculture, University of Illinois at Urbana-Champaign, 1981.
3. Hill, Lowell D., Marvin R. Paulsen, Gene C. Shove, and Terrence J. Kuhn. *Changes in Quality of Corn Between United States and Japan, 1985* (AE-4609). Department of Agricultural Economics, Agricultural Experiment Station, College of Agriculture, University of Illinois at Urbana-Champaign, 1985.
4. Hill, Lowell D., Marvin R. Paulsen, Terrence J. Kuhn, Barry J. Jacobsen, and Richard J. Weinzierl. *Corn Quality Changes During Export from the United States and Japan* (AE-4636). Department of Agricultural Economics, Agricultural Experiment Station, College of Agriculture, University of Illinois at Urbana-Champaign, 1988.
5. This section was adapted from Soule, Merideth, Lowell Hill, and Duane Erickson. *The Growth of the Full-Fat Soybean Industry in the EC: Quality, Policy and Price Issues* (AE 4627). Department of Agricultural Economics, Agricultural Experiment Station, College of Agriculture, University of Illinois at Urbana-Champaign, 1987.
6. Mielke, S., ed. *Oil World.* Hamburg. December 19, 1986, p.405.
7. Bailey, Jeanne Frances. *Factors Affecting the European Community Wet Milling Industry's Demand for U.S. Corn.* Master's Thesis, University of Illinois at Urbana-Champaign, 1987.
8. Paulsen, Marvin R., and Lowell D. Hill. "Corn Quality Factors Affecting Dry Milling Performance." Journal of Agriculture Engineering Research 31(1984):255-263.
9. Weller, Curtis L., Marvin R. Paulsen, and Marvin P. Steinberg. "Correlation of Starch Recovery with Assorted Quality Factors of Four Corn Hybrids." Cereal Chemistry 65, no.5(1988):392-397.
10. Sinclair, James B., and Lowell D. Hill. "In Search of Soybean Quality." Illinois Research 29, nos. 2-3(1987):10.

Table 1. Responses to the Survey of Grain Processing Firms in Western Europe

Firm type	Questionnaires sent	Responses received	
		Total	Usable
Feed manufacturers	810	36 (4.4)	26 (3.2)
Soybean crushers	40	24 (60.0)	22 (55.0)
Corn wet millers	21	10 (47.6)	9 (42.9)
Corn dry millers	17	6 (35.3)	5 (29.4)

NOTE: Numbers in parentheses are percentages of questionnaires sent. Responses include personal interviews.

Table 2. Responses to the Survey of Grain Processing Firms in Japan

Firm type	Number of firms	Completed questionnaires
Feed manufacturers	67	14
Soybean crushers[a]	12	1
Corn wet millers	11	11
Corn dry millers[b]	27	1

a The Japan Oilseed Processors' Association completed one questionnaire representing the consensus of the industry, including 12 firms where soybean crushing was a major activity.
[b] The Japan Corn Grits Association completed one questionnaire representing a consensus of the 27 dry millers in its association.

Table 3. Annual Volume of Soybeans Processed in the European Economic Community and Japan, 1980 to 1986 (Million Metric Tons)

Year	Total volume by EC		Total volume by Japan	
	Respondents[a]	Total[b]	Respondents[a]	Total[c]
1980	—	—	3.45	4.40
1981	4.20	9.97	3.50	4.20
1982	5.00	11.59	3.59	4.34
1983	4.70	10.24	3.93	5.00
1984	3.89	9.30	3.77	4.52
1985	3.93	9.64	3.93	4.19
1986	4.20	12.86	3.90	4.82

[a] Data are from survey responses.
[b] Data are from FEDIOL, Statistique 1986, Brussels, Dec. 1987, p. 13.
[c] Data are from FAO Trade Yearbook.

Table 4. Country of Origin for Western European Soybean Purchases

Year	United States		Brazil		Argentina		Others		Total volume
	mmt	Percent	mmt	Percent	mmt	Percent	mmt	Percent	mmt
1981	3.47	82.6	.39	9.3	.29	6.9	.05	1.2	4.20
1982	4.40	87.9	.37	7.4	.23	4.5	.01	0.2	5.00
1983	3.35	71.4	.83	17.7	.43	9.1	.09	1.8	4.70
1984	2.33	60.0	.89	22.9	.53	13.7	.13	3.4	3.89
1985	2.01	51.2	.94	23.9	.73	18.7	.24	6.2	3.98
1986	2.20	54.0	.45	11.1	.96	23.5	.47	11.4	4.08

SOURCE: Information is from survey responses.
NOTE: Others include European sources as well as origins not identified by the respondents.

Table 5. Country of Origin for Japanese Soybean Purchases

Year	United States		China		Argentina		Brazil		Others		Total volume
	mmt	Percent	mmt	Percent	mmt	Percent	mmt	Percent	mmt	Percent	mmt
1981	4.02	95.8	.11	2.7	.02	0.5	—	—	.04	0.9	4.20
1982	4.20	96.6	.11	2.6	—	—	—	—	.04	0.8	4.34
1983	4.65	93.0	.29	5.8	—	—	.02	0.5	.04	0.7	5.00
1984	4.18	92.6	.31	6.8	—	—	—	—	.03	0.6	4.52
1985	4.35	88.5	.29	5.9	.03	0.7	.22	4.5	.02	0.4	4.91
1986	4.33	89.9	.32	6.7	—	—	.13	2.7	.03	0.7	4.82

SOURCES: Data for 1981 to 1983 were obtained from White Paper on International Trade, published by the Japan External Trade Organization, various issues.
Data for 1984 to 1986 were obtained from Oil World Annual, published by ISTA Mielke GMGH, 1987.
NOTE: Values may not add exactly due to rounding.

Table 6. Frequency of Quality Characteristics Specified in Western European Soybean Processors' Contracts with Major Exporting Countries

Characteristics	United States (19)	Europe (3)	Argentina (14)	Brazil (10)
Physical properties:				
Numerical grade	18	2	1	1
Moisture	15	3	10	8
Density	8	—	1	1
Damage (mold)	10	2	5	5
Broken beans	10	2	3	4
Foreign material	11	3	9	7
Germination	1	—	2	2
Chemical properties:				
Protein	1	—	—	—
Oil	2	1	10	7
Free fatty acid	—	—	1	—
Fiber	1	—	—	—
Other	1	—	2	2

NOTE: Numbers in parentheses represent respondents purchasing soybeans from each country of origin. Other includes the use of FOSFA contracts numbers 22 and 24 and FAQ contract.

Table 7. Quantity of Soybeans Processed by Six FFSB Processors Compared with Annual Average Prices of Soybeans and Soybean Meal (c.i.f. Rotterdam)

Year	FFSB processed by EC-10 respondents (000 mt)	Average price United States soybeans ($/mt)	Average price 49 percent soybean meal ($/mt)	Soybeans/ soybean meal price ratio
1980	84.10	294.00	258.00	1.14
1981	117.96	288.00	252.00	1.14
1982	156.16	244.00	235.00	1.04
1983	338.03	281.00	237.00	1.19
1984	216.30	282.00	197.00	1.43
1985	217.61	224.00	157.00	1.43
1986	321.80	208.00	185.00	1.12

SOURCES: Surveys; *Oil World.*
NOTE: Respondents in the European Community included two firms in 1980, four firms from 1981 to 1982, and six firms from 1983 to 1986.

Table 8. Country of Origin for EC-10 FFSB Purchases

	United States		Brazil		Argentina		Others		Total volume
Year	000 mt	Percent	000 mt	Percent	000 mt	Percent	000 mt	Percent	000 mt
1980	54.8	65.2	2.2	2.6	24.1	28.6	2.9	3.5	84.1
1981	95.8	81.2	5.5	4.7	14.5	12.3	2.0	1.7	118.0
1982	143.9	92.1	0.3	0.2	9.2	5.9	2.8	1.8	115.2
1983	296.1	87.6	18.3	5.4	23.3	6.9	0.4	0.1	338.0
1984	171.1	79.2	8.6	4.0	36.3	16.8	0.0	0.0	216.0
1985	166.2	76.4	11.5	5.3	36.6	16.8	3.5	1.6	217.6

NOTE: Information is from survey responses.

Table 9. Importance of Selected Quality Characteristics to FFSB Processors and Soybean Crushers

Characteristics	FFSB processors (6)				Soybean crushers (19)			
	Included in United States contract		Measured every delivery		Included in United States contract		Measured every delivery	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Physical properties:								
Numerical grade	6	100	2	33	18	100	9	47
Moisture	4	67	4	67	15	79	18	95
Density	2	33	2	33	8	44	5	26
Damage	2	33	1	17	10	56	13	68
Broken beans	1	17	1	17	10	56	14	74
Foreign material	2	33	2	33	11	61	16	84
Germination	1	17	1	17	1	11	4	21
Chemical properties:								
Protein	1	17	4	67	1	6	15	79
Oil	1	17	4	67	2	11	17	89
Free fatty acids	—	—	—	—	—	—	12	63
Fiber	1	17	1	17	1	6	6	32

NOTE: Numbers in parentheses represent survey responses.

Table 10. Country of Origin for Western European Corn Purchases by Wet Millers

Year	Europe		United States		Argentina		Others		Total volume
	mmt	Percent	mmt	Percent	mmt	Percent	mmt	Percent	mmt
1981	.29	17.7	1.34	81.5	—	—	.01	0.8	1.65
1982	.44	26.3	1.21	71.5	.02	1.3	.02	0.9	1.70
1983	.53	30.8	1.09	63.9	.06	3.3	.04	2.0	1.71
1984	1.49	51.2	1.34	46.0	.05	1.5	.04	1.3	2.91
1985	2.15	71.9	.82	27.5	.01	0.4	.01	0.3	2.99
1986	1.80	86.2	.29	13.8	—	—	—	—	2.08

SOURCE: Information is from survey responses.
NOTE: Others include local purchases and unspecified origins.

Table 11. Country of Origin for Japanese Corn Purchases by Wet Millers

Year	China		United States		South Africa		Others		Total volume
	mmt	Percent	mmt	Percent	mmt	Percent	mmt	Percent	mmt
1981	—	—	.18	12.3	1.28	87.7	—	0.0	1.46
1982	—	—	.34	19.1	1.37	76.9	.07	4.0	1.78
1983	—	—	1.84	80.3	.36	15.9	.09	3.8	2.29
1984	.14	6.0	2.06	88.0	—	—	.14	6.0	2.34
1985	.52	21.1	1.12	45.2	.33	13.5	.50	20.2	2.47
1986	.31	13.6	.66	28.4	.99	42.5	.36	15.5	2.33

SOURCE: Information is from survey responses.
NOTE: Others include local purchases and unspecified origins.

Table 12. Frequency of Quality Characteristics Specified in Western European Wet Millers' Contracts with Major Exporting Countries

Characteristics	United States (7)	Europe (7)	Argentina (2)
Physical properties:			
Numerical grade	7	1	—
Moisture	6	5	1
Density	2	—	—
Damage (mold)	3	4	—
Broken corn	3	4	—
Foreign material	3	4	—
Germination	2	2	1
Chemical properties:			
Starch	1	—	—
Protein	1	—	—
Fiber	1	—	—
Oil	1	—	—
Other factors:			
Origin country	—	1	—
FAQ	—	1	1

NOTE: Numbers in parentheses represent respondents purchasing corn from each country of origin.

Table 13. Frequency of Quality Characteristics Specified in Japanese Wet Millers' Contracts with Major Exporting Countries

Characteristics	United States (11)	South Africa (11)	China (6)
Physical properties:			
Numerical grade	5	6	—
Moisture	8	8	2
Density	1	—	—
Damage (mold)	5	4	1
Broken corn	5	4	1
Foreign material	5	7	1
Germination	—	—	—
Chemical properties:			
Starch	4	4	—
Protein	4	4	—
Fiber	4	4	—
Oil	4	4	—

NOTE: Numbers in parentheses represent respondents purchasing corn from each country of origin.

Table 14. Country of Origin for Western European Corn Purchases by Dry Millers

Year	Europe		United States		South Africa		Argentina		Others		Total volume
	mmt	Percent	000 mt	Percent	000 mt	Percent	000 mt	Percent	000 mt	Percent	000 mt
1981	—	—	44	15.7	133	47.5	—	—	103	36.8	280
1982	75	18.9	27	6.8	178	44.8	—	—	117	29.5	397
1983	85	20.9	85	20.9	117	28.7	—	—	120	29.5	407
1984	123	30.8	87	21.8	54	13.5	—	—	135	33.8	399
1985	186	43.1	89	20.6	18	4.2	129	29.9	10	2.3	432
1986	159	35.4	42	9.4	—	—	93	20.7	155	34.5	449

SOURCE: Information is from survey responses.
NOTE: Others include local purchases and unspecified origins.

Table 15. Country of Origin for Japanese Corn Purchases by Dry Millers

Year	China		United States		South Africa		Argentina		Others		Total volume
	000 mt	Percent	000 mt	Percent	000 mt	Percent	000 mt	Percent	000 mt	Percent	000 mt
1981	—	—	203.5	65.0	109.6	35.0	—	—	—	—	313
1982	—	—	106.8	40.0	160.2	60.0	—	—	—	—	267
1983	—	—	221.3	75.0	73.8	25.0	—	—	—	—	295
1984	14.7	5.0	250.0	85.0	14.7	5.0	14.7	5.0	—	—	294
1985	98.1	30.0	212.6	65.0	16.4	5.0	—	—	—	—	327
1986	66.0	20.0	181.5	55.0	82.5	25.0	—	—	—	—	330

SOURCE: Information is from survey responses.
NOTE: Others include local purchases and unspecified origins.

Table 16. Frequency of Quality Characteristics Specified in Western European Dry Millers' Contracts with Major Exporting Countries

Characteristics	United States (3)	Europe (3)	Argentina (2)	South Africa (1)
Physical properties:				
Numerical grade	3	1	—	1
Moisture	3	3	—	—
Density	—	1	—	—
Damage (mold)	1	2	—	—
Broken corn	—	2	—	—
Foreign material	—	2	—	—
Stress cracks	1	—	—	—
Floater test	1	—	—	—
Germination	—	1	—	—
Chemical properties:				
Starch	—	1	—	—
Protein	—	1	—	—
Fiber	—	1	—	—
Other factors:				
FAQ	—	—	2	—
Misc.[a]	3	—	—	—

NOTE: Numbers in parentheses represent respondents purchasing corn from each country of origin.
[a] Other factors include hardness, variety, and odors.

Table 17. Country of Origin for Western European Corn Purchases by Feed Manufacturers

Year	Europe		United States		Argentina		Others		Total volume
	mmt	Percent	mmt	Percent	mmt	Percent	mmt	Percent	mmt
1981	1.12	81.5	.25	18.1	—	0.4	—	—	1.37
1982	1.18	80.6	.26	17.9	.02	1.4	—	—	1.46
1983	1.25	81.3	.26	17.0	.03	1.7	—	—	1.53
1984	1.39	78.4	.30	16.8	.08	4.6	—	0.3	1.77
1985	1.49	79.7	.28	15.1	.09	4.8	—	0.4	1.87
1986	1.98	88.3	.22	10.0	—	0.2	.03	1.5	2.25

SOURCE: Information is from survey responses.
NOTE: Others include local purchases and unspecified origins.

Table 18. Country of Origin for Western European Soybean Meal Purchases by Feed Manufacturers

Year	Europe		United States		Brazil		Argentina		Others		Total volume
	mmt	Percent	mmt	Percent	mmt	Percent	mmt	Percent	mmt	Percent	mmt
1981	.44	42.6	.07	6.5	.30	28.7	.22	20.9	.01	1.3	1.04
1982	.47	39.2	.09	7.7	.32	27.3	.27	22.6	.04	3.3	1.19
1983	.51	40.3	.10	8.1	.31	24.5	.32	25.3	.02	1.7	1.26
1984	.51	38.7	.09	6.8	.33	24.9	.37	28.0	.02	1.4	1.32
1985	.54	37.7	.09	6.3	.34	24.1	.44	30.9	.01	1.0	1.43
1986	.66	32.7	.11	5.4	.77	38.5	.44	22.1	.03	1.3	2.01

SOURCE: Information is from survey responses.
NOTE: Others include local purchases and unspecified origins.

Table 19. Country of Origin for Western European Corn Gluten Meal Purchases by Feed Manufacturers

Year	Europe		United States		Others		Total volume
	000 mt	Percent	000 mt	Percent	000 mt	Percent	000 mt
1981	163	60.3	105	38.9	3	1.1	270
1982	160	57.3	114	40.9	5	1.8	279
1983	217	56.0	166	42.8	4	1.1	388
1984	217	58.0	143	38.2	14	3.7	374
1985	271	19.2	1,130	80.3	7	0.5	1,409
1986	239	16.0	1,248	83.7	4	0.3	1,491

SOURCE: Information is from survey responses.
NOTE: Others include local purchases and unspecified origins.

Table 20. Frequency of Quality Characteristics for Corn Specified in the Western European Feed Manufacturers' Contracts with Major Exporting Countries

Characteristics	United States (7)	Europe (13)	Argentina (3)	South Africa (3)
Physical properties:				
Numerical grade	5	11	2	1
Moisture	4	6	1	1
Density	2	7	—	—
Damage (mold)	4	10	1	1
Broken corn	6	10	1	1
Foreign materials	4	4	3	3
Chemical properties:				
Carbohydrates	3	7	3	3
Protein	5	8	3	3
Fiber	4	—	—	—
Other factors:				
Energy	1	1	1	1

NOTE: Numbers in parentheses represent respondents purchasing corn from each country of origin.

Table 21. Frequency of Quality Characteristics for Soybean Meal Specified in the Western European Feed Manufacturers' Contracts with Major Exporting Countries

Characteristics	United States (11)	Europe (11)	Argentina (5)	South Africa (2)
Moisture	9	9	4	1
Protein	11	11	5	2
Fiber	9	9	4	2
Trypsin inhibitor	3	2	1	
Fat	1	1	—	—
Urease	—	1	—	—

NOTE: Numbers in parentheses represent respondents purchasing soybean meal from each country of origin.

Table 22. Frequency of Quality Characteristics for Corn Gluten Meal Specified in the Western European Feed Manufacturers' Contracts with Major Exporting Countries

Characteristics	United States (9)	Europe (6)	Argentina (2)	South Africa (1)
Moisture	7	3	1	1
Carbohydrates	2	1	1	1
Protein	9	6	2	1
Fiber	6	5	2	1

NOTE: Numbers in parentheses represent respondents purchasing corn gluten meal from each country of origin.

Table 23. Frequency of Quality Characteristics for Corn Specified in the Japanese Feed Manufacturers' Contracts with Major Exporting Countries

Characteristics	United States (14)	China (14)	Argentina (13)	South Africa (3)
Physical properties:				
Numerical grade	13	5	7	3
Moisture	11	10	8	3
Density	6	—	—	—
Damage (mold)	8	7	6	2
Broken corn	8	6	5	2
Foreign material	6	7	4	2
Chemical properties:				
Carbohydrates	2	1	—	1
Protein	3	3	2	1
Fiber	2	2	2	1
Other factors:				
Ash content	1	1	1	—

NOTE: Numbers in parentheses represent respondents purchasing corn from each country of origin.

Table 24. Frequency of Quality Characteristics for Soybean Meal Specified in the Japanese Feed Manufacturers' Contracts with Major Exporting Countries

Characteristics	United States (5)	China (2)	Japan (3)
Moisture	1	1	—
Protein	4	1	—
Fiber	—	—	—
Trypsin inhibitor	—	—	—
Fat	—	1	2
Ash	—	—	3

NOTE: Numbers in parentheses represent respondents purchasing soybean meal from each country of origin.

Table 25. Percentage of Western European Feed Manufacturers Reporting Measurement of Selected Quality Characteristics on Every Delivery

Characteristics	Corn (18)[a]	Corn gluten meal (14)[a]	Soybean meal (23)[a]
Physical properties:			
Numerical grade	16.7	N/A[b]	N/A
Moisture	72.2	78.6	69.6
Density	33.3	N/A	N/A
Damage (mold)	38.9	N/A	N/A
Broken corn	66.7	N/A	N/A
Foreign material	55.6	N/A	N/A
Chemical properties:			
Carbohydrates	27.8	50.0	N/A
Protein	50.0	85.7	73.9
Fiber	44.4	78.6	56.5
Trypsin inhibitor	N/A	N/A	30.4

[a] Percentage is based on number of respondents for each product.
[b] N/A means not applicable.

Table 26. Percentage of Japanese Feed Manufacturers Reporting Measurement of Selected Quality Characteristics on Every Delivery

Characteristics	Corn (14)[a]	Corn gluten meal (13)[a]	Soybean meal (14)[a]
Physical properties:			
Numerical grade	71.4	N/A[b]	N/A
Moisture	64.2	61.5	50.0
Density	—	N/A	N/A
Damage (mold)	14.3	N/A	N/A
Broken corn	35.7	N/A	N/A
Foreign material	35.7	N/A	N/A
Chemical properties:			
Carbohydrates	14.3	—	N/A
Protein	57.1	69.2	57.1
Fiber	14.3	7.7	7.1
Trypsin inhibitor	N/A	N/A	7.1

[a] Percentage is based on number of respondents for each product.
[b] N/A means not applicable.

AUTHORS: Lowell D. Hill is the L.J. Norton Professor of Agricultural Marketing in the Department of Agricultural Economics at the University of Illinois at Urbana-Champaign, Illinois.
Karen L. Bender is a visiting research specialist in the Department of Agricultural Economics at the University of Illinois at Urbana-Champaign, Illinois.
Kandeh Yumkella and Shailendra K. Pradhan are graduate students in the Department of Agricultural Economics at the University of Illinois at Urbana-Champaign, Illinois.
Kenji Horiguchi is a professor in the Department of Agricultural Economics at the Tokyo University of Agriculture in Tokyo, Japan.

Editor: Anita Povich
Designer: Krista Sunderland

Office of Agricultural Communications and Education at the University of Illinois at Urbana-Champaign.

1.5M– 9-90–PRINTEC–AP