Chapter 2: The Potential for Expantion in the Grain Sorghum and Barley Markets in Virginia

Section 2.1: Introduction & Grain Summary

Producers continually face the problem of determining the optimal crop mix among possible alternatives for their farmland in a given location. These decisions are based on a number of factors such as the estimated costs of production, potential yield per acre, and expected farm level price for each crop. Prior to the changes in the farm program, producers decisions regarding the expansion of alternative crop acreage would have been restricted by their participation in the farm program. The opportunity costs associated with converting land from existing production to alternative crop production was reduced by passage of the Federal Agriculture Improvement and Reform (FAIR) Act in 1996, which eliminated target prices and acreage restrictions for wheat, corn, grain sorghum, barley, oats, rice, and upland cotton. As a result, producers' planting decisions are affected by the end-use demand for grain, not government programs. The quantity of a grain consumed as feed or food, domestically and in other countries, ultimately determines how much grain is purchased from farmers, as well as the farm income generated by the grain.

Producers of agricultural commodities are generally price takers; therefore, the quantity demanded by end-users determines the farm price. Individual producers take what country elevators, feed processors, and exporters, are willing to pay for a specific amount and quality of grain. Assuming that grain supplies will sufficiently meet demand, when end-use demand for a grain is low, relative to alternative crops, farmers receive lower prices for their grain. Producers translate these price signals into expectations regarding income generated by specific crops.

Within a crop year, declining demand for grain is reflected in a low price offered by end-users, which may result in more grain going into storage. Depending on the cost of storing grain and available storage space, producers may respond to declining prices due to an abundance of grain at harvest, by selling their grain towards the end of the marketing year when rationing existing stocks may result in higher farm level prices. For example, the farm price may rise during the crop year in response to constant or increasing end-use demand and a decreasing limited supply of grain. However, in the long-run, producers will respond to low grain prices by decreasing planted acreage the following year. As producers' average net income decline because of lower farm level prices for specific commodities, producers have an incentive to substitute alternative crops in their production schemes. The expected net returns from an alternative crop must be greater than the net returns the producers is currently receiving. Producers respond to a decline in grain prices by restricting supply, in the short-run via storage and in the long-run via choice of crops. Producers respond to changes in demand, indicated by price signals, when they decide to produce an alternative crop.

Crop alternatives not only have to agronomically "fit" in existing crop rotations, they must also be economically viable in terms of costs and net returns at every level in the marketing system. The development of any commodity market is dependent on the ability of firms at the first handler level (country elevators, feedmills, and exporters) to generate revenue from buying and selling the commodity. Thus, in order to provide first level handlers with an economic incentive to buy and sell a commodity, such as grain sorghum or barley, it would have to be a demand substitute, as well as an agronomic substitute. In Virginia, a crop alternative's economic viability would depend on whether or not it could be substituted for corn in feed mixtures and maintain the feed's nutritional content without increasing its cost.

Country elevators, feedmills and exporters were grouped at the first level of the marketing system because they are the *middlemen* in Virginia's marketing system (see Figure 2-1). This study collapses country elevators, feed processors, and exporters into one marketing level because their participation in the grain market was considered vital to the expansion of any grain's share of the market. The incentive for the first level handlers is illustrated on Figure 1-2 by the farm-first level price spread, which represents the difference between the price first level handlers pay farmers for a commodity and the price first level handlers sell the commodity. If the farm-first level price spread narrows when additional grain enters the market, the economic incentive associated with handling the grain is reduced. Eventually, as the price spread narrows, additional grain would not enter the marketing system and the grain's market share would not expand in Virginia. In the actual marketing system it is possible for first level handlers to sell grain to each other, for example the country elevator can sell grain to the exporter.

Section 2.1.1: Perfectly Competitive Market

In a perfectly competitive market, there are no barriers to market entry. Perfect competition assumes that a larger number of buyers and sellers, acting independently, exchange a standardized product. Factors such as government regulations, price collusion, limited number of firms, or imperfect information can interfere with the mechanics of a competitive market and create artificial barriers to market entry. The objective of this study is to analyze potential market barriers that prevent grain sorghum and barley from expanding their share of the Virginia grain market. Market barriers have the potential to negatively impact demand, supply, markets prices, and transaction costs. Transaction costs include the costs associated with production, transportation, storage, information, contract enforcement, and risk management.

Market barriers impact the market signaling process because barriers tend to discriminate against at least one party in the marketing system. For example, a limited number of firms who purchase a specific commodity have more market power compared to a large number of firms who sell a specific commodity. Interactions between the supply and demand schedule for this commodity's market will be influenced by the ability of a few firms to dictate the price offered for the commodity, which would result in increasing the variability of the market clearing price.

Another example is the affect imperfect information has on the marketing system. If the actual quality and quantity of a commodity is not known by all of the markets participants, expectations regarding supply and demand will not reflect actual market conditions. In this case, market uncertainty would affect the interaction between supply and demand, also resulting in increased price variability.

Section 2.1.2: Grain Sorghum(Milo) Situation

Approximately 95% of US grain sorghum is used as feed for swine, poultry, and cattle. Texas, Kansas, Nebraska, and Missouri accounted for 83% of US milo production in 1992. Unlike other feed grains, very little milo is used in food (less than 1% in 1994). However, grain sorghum is used in feed mixtures and ethanol plants. Ethanol plants in the midwest typically price sorghum 15 cents under corn; however, the limited corn supplies in 1995 and 1996 have resulted in plants buying sorghum at 5 cents under the price of corn.

While, it is not likely that grain sorghum produced in Virginia will be purchased for use in midwestern ethanol plants, there are indications that grain sorghum has potential to be used as feed in the state. Virginia livestock and poultry producers have been faced with rationing local corn supplies. The consistent decline in corn acreage has forced livestock and poultry producers to transport corn from the Midwest, primarily Ohio. Assuming that feed grain users are cost minimizes, they will always buy grain from the cheapest source. Using locally produced grain sorghum would eliminate the cost of transporting corn from the Midwest, lowering the costs of production for livestock and poultry producers. As long as grain sorghum can be substituted in feed mixtures for corn without compromising the nutritional value of the feed, it may be a cheaper source of feed in Virginia. The average feed value for grain sorghum, compared to corn is 94%. For poultry the feed value of grain sorghum is 98% of corn and for swine the feed value is 95-97% of corn (National Research Council Nutrient Requirements for Swine, 1988).

Section 2.1.3: Barley Situation

Barley is the third leading cereal crop in the US and the world; however, the US is a relatively small exporter of barley. China, Thailand, and Korea are increasing the amount of barley imported from the US but Virginia barley will not be exported to Asia because it cannot compete with of the quality and location of western barley producing states. European exporters may have a competitive advantage over US exporters because of the transportation costs involved. Therefore, the potential for barley as an alternative crop in Virginia depends on local feed grain demand.

Barley consumption is concentrated primarily in the Western states, where the demand for barley as a feed grain competes with the demand for corn, even though it competes with wheat for acreage (Wilson, Scherping, Cobia, & Johnson, 1993). Wilson (1983) found the demand for barley as feed was "very" sensitive to the price of other sources of feed, especially corn and soybean meal. In the early 1980's, barley prices increased relative to corn prices and resulted in a decreasing quantity of barley used as a feed grain (Wilson 1983).

Acreage is allocated for barley production based on expected net returns per acre relative to alternative crops, primarily wheat. When making production decisions, farmers factor in their ability to diversify production risk and their ability to contract to sell alternative grains. This is an important decision making factor because there are no futures contracts for barley. The Minneapolis Grain Exchange (MGE) is one of the few public cash markets for malting barley in the world. The MGE is where a majority of the buyers and sellers of barley meet to make transactions. It offers futures contracts for wheat and sunflower, which provide limited hedging opportunities for firms who handle barley. "Consequently, their [producers] exposure to price risk is greater in barley compared to other grains (Heid, p. 12)."

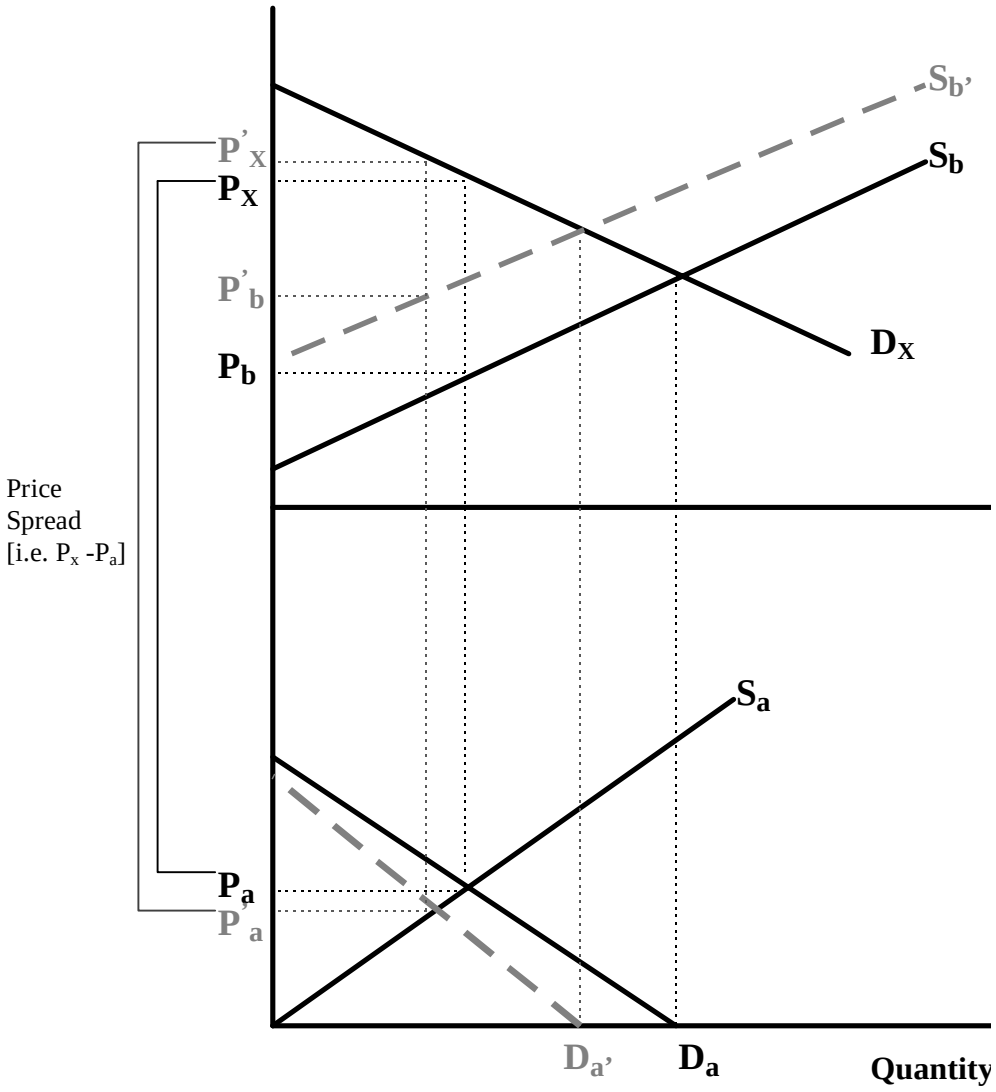
In 1993, Al-Zubaidy found that high-protein barley could effectively replace one half the mass of corn in the feed ration without adversely affecting the growth of chicks with only a *slight* increase in feed consumption. Compared to corn, wheat, and soybeans, high protein barley can provide a lower cost per unit of energy and unit of protein in poultry diets. The benefits of high-protein varieties are not capitalized on by dairy cows or swine. When protein levels are less than 12%, feed values are also significantly low, and when protein levels are greater than 12%, feed values are not significantly higher. LaFrance and Watts (1986) found that the protein content/feed value relationship is concave when barley is fed to dairy cows or swine.

In a recent study (Brake, Wolford, & Parson, 1995), the Department of Animal and Poultry Science at Virginia Tech found that that highest relative value of barley in broiler diets would be 83% of corn, if dietary cost savings are not a factor. On the average, for poultry, barley has a feed value of 79% compared to corn (National Research Council Nutritional Requirements for Poultry, 1994). For swine, barley's feed value ranges form 90 to 100% of corn (National Research Council Nutritional Requirements for Swine, 1989). According to the National Research Council, the average overall feed value for barley, compared to corn is 84%.

Therefore, it became apparent that the expansion of grain sorghum and barley in Virginia would rely on the grains' ability to find a niche in the local feed grain market. Increasing demand for grain sorghum and barley as feedsources, would increase the expected farm price of both grains, and provide the incentive to substitute grain sorghum and barley in crop mixes. However, because grain sorghum and barley are not widely produced in the state, despite the appearance of being "good" alternative crops, it can be assumed that their expansion may be constrained by factors other than supply, demand, and price. The study's objectives focused on identifying potential market barriers that could negatively influence the perception of grain sorghum and barley's ability to become economically viable crop alternatives in Virginia.

Section 2.2: Objectives

The development of any commodity market is dependent on the ability of firms at the first handler level to generate revenue from buying and selling the commodity, unless the market is vertically integrated. The farm-first level price spread for a commodity provides first level handlers with the incentive to enter the market. The supply and demand for a commodity at all levels of the marketing system influence the farm-first handler price spread, which provides first handlers with the incentive to enter a specific market. Factors that would potentially decreases first level firms net revenues, such as increased costs, would constrain the expansion of grain sorghum and barley feed grain markets. For example, transaction costs (P_b) influence the magnitude of the price spread firms perceive as necessary to provide the incentive to handle the commodity. Expecting increased transactions costs associated with grain sorghum or barley, illustrated on Figure 2-2 by an increase in P_b to P'_b, results in a decrease in demand (D_a) and price (P_a) at the farm level.



Legend:
a = Grain Sorghum or Barley
b = Transaction Costs
X = Feed
S = Supply
D = Demand
P = Price

Figure 2-2: Increased Price Spread Due to Increased Transactions Costs

The overall goal of the study is to evaluate the potential of grain sorghum and barley as alternative crops in Virginia; thus, No. 2 grain sorghum is compared to No. 2 yellow corn, and No. 2 barley is compared to No. 2 soft red winter wheat and No. 2 yellow corn. Because barley competes with wheat for acreage and corn for a share of the feed grain market, it has to be competitive with both grains if barley production is to expand in Virginia. To be viable crop alternatives, grain sorghum and barley have to be perceived as economically competitive substitutes for corn and wheat in the market.

Also, the infrastructure of the Virginia grain market may prohibit the entrance of grain sorghum and barley, and therefore, discourage grain sorghum and barley from expanding their share of the market. Market infrastructure refers to the existing physical characteristics of Virginia elevators and feedmills, as well as, the forces that influence grain prices. The costs associated with reinvesting in the infrastructures assets, such as permanent storage space, in order to accommodate grain sorghum or barley may be greater than the expected revenue associated with these grains. The "stickiness" of the existing infrastructure will determine the markets ability to adapt to an increase in grain sorghum or barley production. One fixed asset, land, has become less "sticky" because by eliminating the annual acreage programs the FAIR Act gives producers' more flexibility to react to changes in demand. However, the decrease in opportunity costs associated with participation in the farm program may not offset additional production costs associated with alternative crops. The following three objectives were developed based on the economic factors considered to be influential in the development of grain markets.

Section 2.2.1: Study's Three Objectives

1. Does the existing structure of the Virginia grain industry favor buying and selling yellow corn or soft red winter wheat, and therefore, impede the development grain sorghum or barley markets?
2. Has the undeveloped market for grain sorghum and barley contributed to inconsistent production of small grains in the state?
3. Do the grain characteristics, including nutritional value, desired by livestock and poultry producers and the relative cost of these characteristics hinder the expansion of the grain sorghum and barley markets in the state?

Section 2.3: Methods

An analysis of available secondary data indicated that there was insufficiently detailed information to meet the study's objective because the available information did not include current data regarding acreage and prices. The *Virginia Agricultural Statistics 1975 - 1994* provides annual grain production information for corn, winter wheat, and barley. Weekly regional price

quotes for yellow corn, soft red winter wheat, and barley, are reported by the *Virginia Commodity Newsletter*. Due to the small acreage of grain sorghum in Virginia, very little historical data has been recorded. The *Virginia Agricultural Statistics* discontinued recording information concerning the annual production for grain sorghum in 1985, and the *Virginia Commodity Newsletter* does not quote grain sorghum prices.

Consequently, it was necessary to collect data from primary sources. In order to obtain the information needed to address the study's objectives a survey instrument was designed to elicit information from grain elevators, feedmills and exporters in Virginia. The survey was developed with the expectation that the factors, such as increased transaction costs, that discourage these firms from handling grain sorghum and barley are the same factors that discourage the expansion of the grain sorghum and barley markets (see Section 2.6: Appendix A: Initial Survey Instrument and Additional Questions).

Section 2.3.1: Survey Participants

Survey participants were identified in three ways: (1) Any elevator and/or feedmill that filed a discount sheet with the Virginia Department of Agriculture and Consumer Services for grain sorghum and/or barley in 1993 or 1994 was identified as a potential participant in the market; (2) The *1993 Southeast Grain and Feed Association Directory* was used to identify any Virginia elevator and/or feedmill that handled grain sorghum and/or barley. (3) Respondents were asked to identify any additional elevators, feedmills, and/or exporters that sold grain sorghum and/or barley. Any firm listed, not previously identified, was added to the survey, including those in Pennsylvania, Maryland, and North Carolina who were identified as buyers of Virginia grain. The resulting survey population included forty-three firms that currently handled one or both of the grains in the study and twenty-one firms who had discontinued handling one or both grains.

Section 2.3.2: Elicitation of Survey

A random sample would have severely limited the sample population; therefore, all forty-three firms identified as currently handling grain sorghum and/or barley were included in the survey. A *pilot* test was not an option because of the limited market population. To avoid any misinterpretations, the initial study population was personally interviewed.

Ideally, every questionnaire in the study would be filled out through personal interview but time and financial constraints did not allow for a large number of interviews. The remaining participants were contacted by phone, asked if they would participate in the study, and approximately one week after the survey was mailed, a follow up phone call was made to address any concerns. The goal was to include the market participants who account for more than 70

percent of market volume for grain sorghum and barley in the survey. However, an overwhelming majority of respondents, refused to answer the questions designed to elicit market volume information because this information was considered privileged. First-level handlers who were identified, *a priori*, as handling the majority of Virginia grain did participate in the survey.

Appendix A (Section 2.6) contains a copy of the initial survey instrument and a copy of the additional questions that were included to determine why twenty-one firms stopped buying and selling grain sorghum and/or barley. The additional questions focused on six factors: costs associated with handling the grain; risk associated with the grain; handling capacity of the operation; nutritional content of the grain; lack of consistent local supply; and limited demand for the grain as a feedsource. The twenty-one firms who discontinued handling grain sorghum and/or barley were questioned during a phone interview.

Section 2.3.3: Establishing Testable Hypotheses

Hypotheses are assumptions or tentative theories about the population being surveyed. Each hypothesis is based on a factor identified in the three objectives as a possible constraint to the expansion of the grain sorghum and barley markets in Virginia. The survey instrument was constructed using open-ended questions, simple alternative questions (Yes/No), and multichoice questions. The number of strictly open-ended questions was limited to the elicitation of additional explanations or descriptions. To determine whether a factor acts as a market barrier, a two-tailed hypothesis test is constructed to identify the differences between an established grain market (yellow corn and soft red winter wheat) and the developing grain market (grain sorghum and barley). Hypothesis testing is utilized because it allows statements regarding the characteristics of a population to be quantified as to the significance of their influence. It invokes the use of tests of significance, which are important in determining whether the noted differences between two samples are the results of a chance variation or whether they are actually significant (Chisnall, 1981).

Two types of errors can occur when using hypothesis testing, known as type I and type II errors. A type I error occurs when a null hypothesis is actually true, but the statistical test leads the researcher to conclude that it is "probably false." A type II error occurs when a false H_O is found to be "probably true." The significance level of the test refers to the maximum probability a type I error will occur. To avoid any bias, the acceptable probability level, α, should be specified prior to examining the results of the survey. For this study the acceptable probability level was 5 percent, giving the hypotheses tests a confidence interval of 95 percent.

The test does not prove *absolutely* that a stated hypothesis is true or false because the results are contingent upon the responses of a sample of the population who responded to the questionnaire. "Moser (1971) warns that although a test may produce a negative result, it cannot be automatically assumed that the effect does not exist in the entire population under survey

(*Ibid.*, p 139 [secondary source])." Even though this study attempted to include the entire market population in the survey population, a 100% response rate was not achieved, leaving room for type I and type II errors.

When the number of observations available for analysis are less than 30 (n < 30), the 't' distribution is used to accept or reject a null hypothesis as opposed to the normal distribution Table. Because the population variance(σ^2) is unknown, the sample estimate$\left(s^2 = \frac{1}{n-1} \right)$ must be used, making the standard deviation, s , equal to $\sqrt{\frac{1}{n-1}}$. It was assumed as n becomes larger (n > 30), $'t' = \frac{\bar{x} - \mu}{(s/\sqrt{n})}$ with (n -1) degrees of freedom approaches the normal distribution; therefore, it was also assumed that the populations were normally and independently distributed.

In cases where the hypothesis test compares more than two population means, a one way analysis of the variance (ANOVA) examines the population variances and determines if population means are equal, without compounding the probability of a type I error. If more than one *t* test is done to compare more than two population means, the actual α becomes larger and the risk of rejecting a true hypothesis increases. The ANOVA makes the same assumptions as the t-test. Three variations are recorded by the test: (1) total variation; (2) within-sample variation; and (3) between-sample variation. The decision rule is based on the F distribution, and if the calculated F $\left(\frac{\text{Mean Square Between (MSB)}}{\text{Mean Square Within (MSW)}} \right)$ is greater than the tabulated $F_{critical}$, H_O is rejected. If the null hypothesis is rejected, the alternative hypothesis (H_A) that not all the means are equal, is accepted. *Scheffe's method of multiple comparisons* is used to determine which means are statistically different (Gorber & Shannon, 1989). The *Scheffe's method* was chosen, over the *Turkey's method*, because it can be used when sample sizes are not equal.

Section 2.3.4a: Objective 1, Hypotheses 1-5 & Statistical Test Results

Objective #1:

Does the existing structure of the Virginia grain industry favor established grains, such as yellow corn or soft red winter wheat, and therefore, impede the development of grain sorghum or barley markets?

Hypothesis #1: Transaction Costs (Relates to Questions 6 and 7 of Survey)

Transaction costs are the costs associated with the actual handling of the grain and gathering information regarding the grain's availability and quality. If the grains are substitutes in a competitive market the costs associated with handling each grain would not be significantly different. Every buyer and seller would have access to information (market transparency) regarding the quality and availability of all four grains in question. It was assumed *a priori* that the grain market in Virginia was not fully transparent and that the transaction costs associated with grain sorghum and barley were a possible market barrier. For example, in a fully transparent market if the price spread between P_a and P_x is the same for both grain sorghum and corn. If the transactions costs (P_b) associated with grain sorghum are greater, the price spread associated with grain sorghum also increases to P_x' - P_a' (see Figure 2-2). The same relationship was also assumed to exist for barley and soft red winter wheat in a fully transparent market. Transaction costs are the cost of doing business and in this study they included marketing information, transportation equipment, contracting, ensuring delivery, bin type, drying equipment, loading /unloading equipment, and additional labor.

Hypothesis 1: Across first level handlers, the transactions costs associated with the market exchange of grain sorghum (barley) are greater than those associated with yellow corn (soft red winter wheat) markets. **i.e.** $H_O: \mu_x = 0$

$H_A: \mu_x \neq 0$

where: μ_x = mean response to survey questions six and seven.

Grain Sorghum vs. Corn: $t_{calculated} = 2.314 > t_{critical} = 2.160$. Therefore, the null hypothesis was rejected. Transaction costs associated with the market exchange of grain sorghum are not greater than those associated with corn.

Barley vs. Winter Wheat: $t_{calculated} = 0.950 < t_{critical} = 2.101$. Therefore, the null hypothesis failed to be rejected. Transaction costs associated with the market exchange of barley are greater than those associated with winter wheat.

Hypothesis #2: Marketing Risk (Relates to Questions 9 and 10 of Survey)

Two factors need to be considered when the overall marketing risk associated with any commodity increases: (1) the increase in the cost of managing risk, and the resulting impact on total costs; and (2) the increase in the *expected* farm-first level price spread needed to provide the incentive to continue to handle the commodity. It was assumed that if firms have a choice between two grains, they will tend to favor the grain that is less risky to handle because the transaction costs associated with the grain is lower and the net returns are more stable.

Overall marketing risk includes uncertainty about grain quality, supply, demand, and price. Market or institutional processes provide first level handlers of yellow corn and soft red winter wheat with the information needed to develop reasonable expectations regarding the crops quality, supply, demand, and price received. The price risk associated with No. 2 yellow corn and No. 2 soft red winter wheat can be managed using forward contracts, futures, or options on futures. Grain sorghum and barley are not produced on a large scale in Virginia, the historical information needed to develop expectations is limited, and only forward contracts can be used to manage price risk. Futures and options on futures for grain sorghum and barley are not traded on large established commodity exchanges. Compared to corn and winter wheat, this lack of information increases the level of uncertainty and the overall marketing risk associated with grain sorghum (barley). Therefore, it was assumed *a priori* that the overall marketing risk for grain sorghum (barley) is greater than the overall risk associated with corn (wheat).

Hypothesis 2: Across first handlers, the overall risk associated with the marketing activities for grain sorghum (barley) is equal to that of corn (winter wheat).

i.e. $\mathbf{H_O}$: $\mu_C = \mu_{GS}$ or $\mu_C - \mu_{GS} = 0$ $\quad\quad$ $\mu_{WW} = \mu_B$ or $\mu_{WW} - \mu_B = 0$

$\mathbf{H_A}$: $\mu_C \neq \mu_{GS}$ or $\mu_C - \mu_{GS} \neq 0$ $\quad\quad$ $\mu_{WW} \neq \mu_B$ or $\mu_{WW} - \mu_B \neq 0$

where: μ_C = mean rank for the marketing risk associated with corn.
μ_{WW} = mean rank for the marketing risk associated with winter wheat.
μ_{GS} = mean rank for the marketing risk associated with grain sorghum.
μ_B = mean rank for the marketing risk associated with barley.

Grain Sorghum vs. Corn: $t_{calculated} = 0.299 < t_{critical} = 2.036$. Therefore, the null hypothesis failed to be rejected. Overall marketing risk associated with grain sorghum and corn are not statistically different.

Barley vs. Winter Wheat: $t_{calculated} = -0.914 > t_{critical} = -2.045$. Therefore, the null hypothesis failed to be rejected. Overall marketing risk associated with barley and winter wheat are not statistically different.

Hypothesis #3: Price Risk (Related to Question 8 of Survey)

Firms can limit the costs associated with price discovery by using futures, and options on futures, for yellow corn and soft red winter wheat. The less information available about a grain the more risk there is attached to the firm's income generated by buying and selling the grain. The futures market price reflects the current information on supply, and demand of the grain available in the underlying physical market. The futures market acts as a tool to manage risk incurred by the fluctuations in grain prices, such as seasonal fluctuations at harvest. The study assumed, *a priori*, that elevators, feedmills, and exporters who use the futures market to manage price risk will favor corn and winter wheat compared to grain sorghum and barley, which are not traded on a commodity exchange. In order to test the assumption that the lack of futures and options for grain sorghum and barley act as a barrier to the development of these markets in Virginia, the percentage of marketing activities covered by the futures market was compared to the percentage covered by cash and all forward contracts, for corn and winter wheat.

Hypothesis 3: The percentage of marketing activity covered by futures and options on futures (nontraditional methods) is equal to the percentage of marketing activity covered by cash and forward contracts (traditional methods) for corn (winter wheat).

i.e. $H_O: \mu_1 = \mu_2$ or $\mu_1 - \mu_2 = 0$

$H_A: \mu_1 \neq \mu_2$ or $\mu_1 - \mu_2 \neq 0$

where: μ_1 = percentage of marketing activity covered by cash and all forward contracts.

μ_2 = percentage of marketing activity covered by futures and options on futures.

Corn: $t_{calculated} = 1.475 < t_{critical} = 2.036$. Therefore, the null hypothesis failed to be rejected. The percentage of marketing activities covered by nontraditional means is not statistically different from the percentage covered by traditional means for No. 2 yellow corn.

Winter Wheat: $t_{calculated} = 1.435 < t_{critical} = 2.052$. Therefore, the null hypothesis failed to be rejected. The percentage of marketing activities covered by nontraditional means is not statistically different from the percentage covered by traditional means for No. 2 soft red winter wheat.

Hypothesis #4: Perception of Spot Prices (Related to Question 11 of Survey)

Feed markets in the southeast use corn equivalencies to compare the values of different grains. Feed values, based on corn, represent how many bushels of a grain it would take to equal the nutritional value in one bushel of corn. Feed values take into account digestible nutrients, as well as overall nutritional content, such as protein and fiber levels. If the feed value for grain sorghum is 94%, it would take 1.04 bushels of grain sorghum to equal the feed value in one bushel of corn. In a perfectly competitive market, if firms were given a series of spot prices for corn and asked to give their spot prices for grain sorghum or barley, their bids should be based on the feed values of grain sorghum and barley. Because the grain market in this region is based on corn equivalents, the feed values for all grains are calculated compared to yellow corn.

Question 11 listed a series of spot prices from $1.50 to $3.50 for No. 2 yellow corn and asked the firm for a series of prices they would pay for No. 2 barley and No. 2 grain sorghum given the spot price for corn. The hypothesis was designed to test if the spot prices offered for grain sorghum and barley accurately reflected the feed value of the grains, compared to corn. This hypothesis considers the possibility that the small grains market was constrained because farm prices do not reflect the true value of the grains; therefore, producers lack incentive to change their crop mix.

Hypothesis 4: Given the spot price of corn, first level handlers' bid price for grain sorghum and barley are equivalent to the feed values for grain sorghum and barley.

i.e. H_O: $\mu_1 = \mu_2$ or $\mu_1 - \mu_2 = 0$

H_A: $\mu_1 \neq \mu_2$ or $\mu_1 - \mu_2 \neq 0$

where: μ_1 = feed value of grain sorghum (barley) compared to corn.

$$\mu_2 = \frac{\text{estimated spot price of grain sorghum or barley}}{\text{spot price for corn}}$$

Grain Sorghum vs. Corn: $t_{calculated} = 3.672 > t_{critical} = 2.032$. Therefore, the null hypothesis was rejected. Given the price of corn, first level handlers' bid price for grain sorghum was equivalent to the 94% feed value of corn.

Barley vs. Corn: $t_{calculated} = 6.252 > t_{critical} = 1.989$. Therefore, the null hypothesis was rejected. Given the price of corn, first level handlers' bid price for barley was equivalent to the 84% feed value of corn.

Hypothesis #5: Market Prices (Related to Questions 3 and 4 of Survey)

In the case of grain sorghum (barley), it was assumed, *a priori*, that the bid prices of elevators, feedmills, and grain exporters included compensation for increased market risk, compared to corn (winter wheat), including questionable local supply and demand. If bid prices are based on factors other than supply, demand, and quality, grain producers compensation may be less than the true value of their grain as livestock and poultry feed. Therefore, the actual prices for grain sorghum and barley in Virginia may not provide any incentive to increase the production of grain sorghum (barley) and may act as a barrier to the expansion of the market.

Hypothesis 5: The feed value of grain sorghum (barley) compared to corn is equal to the firm's bid price of grain sorghum (barley) as a percentage of the bid price for corn.

i.e. H_O: $\mu_1 = \mu_2$ or $\mu_1 - \mu_2 = 0$

H_A: $\mu_1 \neq \mu_2$ or $\mu_1 - \mu_2 \neq 0$

where: μ_1 = feed value of grain sorghum (barley) compared to corn.

$$\mu_2 = \frac{\text{bid price of grain sorghum or barley}}{\text{bid price of corn}}$$

Grain Sorghum vs. Corn: $t_{calculated} = -0.788 < t_{critical} = 2.179$. Therefore, the null hypothesis failed to be rejected. First level handlers' bid price for grain sorghum is equivalent to the 94% feed value for grain sorghum compared to corn.

Barley vs. Corn: $t_{calculated} = 13.331 > t_{critical} = 2.059$. Therefore, the null hypothesis failed to be rejected. First level handlers' bid price for barley is equivalent to the 84% feed value for barley compared to corn.

Section 2.3.4b: Objective 2, Hypothesis 6 & Statistical Test Result

Objective #2:

Has the undeveloped market for grain sorghum and barley contributed to the inconsistency of small grain production in the state?

Hypothesis #6: Local Availability (Related to Additional Survey Questions)

As local supplies decline, marginal costs for handling the grain will increase on a per unit basis. As a result, firms would be faced with increasing costs and decreasing net returns. In the absence of the expectation that a minimum amount of grain will be produced locally, there is little economic incentive to market the grain, especially if transactions costs increase due to the additional costs associated with finding buyers for grains that are not widely used as feed in Virginia.

Firms who discontinued handling grain sorghum and/or barley were asked if they agreed with the following statement: "the lack of local supply was a factor in your decision to discontinue handling grain sorghum (barley)."

Hypothesis 6: The lack of local production was not a reason firms stopped buying and selling grain sorghum (barley). **i.e.** $H_O: \mu_x = 0$

$H_A: \mu_x \neq 0$

where: μ_x = mean response to survey question.

Grain Sorghum: $t_{calculated} = 7.407 > t_{critical} = 2.440$. Therefore, the null hypothesis was rejected. The lack of locally produced grain sorghum was not a factor in the firm's decision to discontinue handling grain sorghum.

Barley: $t_{calculated} = 18.993 > t_{critical} = 2.201$. Therefore, the null hypothesis was rejected. The lack of locally produced barley was not a factor in the firm's decision to discontinue handling barley.

Section 2.3.4c: Objective 3, Hypotheses 7 - 10 & Statistical Test Results

Objective #3:

Do the grain characteristics desired by livestock and poultry producers and the relative cost of these characteristics constrain the expansion of the grain sorghum and barley markets in the state?

Hypothesis #7: Lack of Local Use (Related to Additional Survey Questions)

The demand for grain sorghum and barley as feed provides the incentive for first level firms to handle a grain because net returns are directly related to the quantity of the grain they sell. Inconsistent local use of grain sorghum and barley as livestock or poultry feed in the past may prevent the expansion of these markets.

Firms who discontinued handling grain sorghum and/or barley were asked if they agreed with the following statement: "was the demand for the grain as a feedsource a factor in your decision to discontinue handling grain sorghum (barley)."

Hypothesis 7: The lack of local use was not a reason firms stopped buying and selling grain sorghum (barley). **i.e.** $H_O: \mu_x = 0$

$H_A: \mu_x \neq 0$

where: μ_x = mean response to survey question.

Grain Sorghum: $t_{calculated} = 1.550 < t_{critical} = 2.440$. Therefore, the null hypothesis failed to be rejected. The demand for grain sorghum as a source of animal feed was not a factor in the firm's decision to discontinue handling the grain.

Barley: $t_{calculated} = 3.010 > t_{critical} = 2.201$. Therefore, the null hypothesis was rejected. The demand for barley as a source of animal feed was a factor in the firm's decision to discontinue handling the grain was rejected.

Hypothesis #8: Nutritional Value (Related to Additional Survey Questions)

Discussions with industry participants led to an *a priori* expectation that first level handlers perceived that the nutritional value of grain sorghum and barley was not competitive with established sources of animal feed in the region. Firms who discontinued handling grain sorghum and/or barley were asked if they agreed with the following statement: "the nutritional content of the grain was a factor in your decision to discontinue handling grain sorghum (barley)."

Hypothesis 8: The nutritional content of grain sorghum (barley) was not a factor in the firms decision to discontinue handling the grains.

i.e. $H_O: \mu_x = 0$

$H_A: \mu_x \neq 0$

where: μ_x = mean response to survey question.

Grain Sorghum: $t_{calculated} = 1.010 < t_{critical} = 2.440$. Therefore, the null hypothesis failed to be rejected. The nutritional content of grain sorghum was not a factor in the firm's decision to discontinue handling the grain.

Barley: $t_{calculated} = 1.000 < t_{critical} = 2.401$. Therefore, the null hypothesis failed to be rejected. The nutritional content of barley was not a factor in the firm's decision to discontinue handling the grain.

Hypothesis #9: Total Digestible Nutrients (TDN%) (Related to Question 1 of Survey)

The percentage of total digestible nutrients (TDN%) is the percentage of the nutrients in a grain digested by a specific species. TDN% is a specific measurement of nutritional value that takes into account the digestibility of each grain based on the species being fed. The higher the TDN%, the more effective the grain is as an input in feed mixtures. The nutritional value of a feed source may be a critical factor to grain buyers and may influence the grain's expansion as an alternative crop.

Hypothesis 9: The TDN% per bushel of grain was not a factor in the feedmills decision to purchase inputs, such as corn or grain sorghum.

i.e. $H_O: \mu_x = 0$

$H_A: \mu_x \neq 0$

where: μ_x = mean response to survey question one.

Results: $t_{calculated} = 3.130 > t_{critical} = 2.306$. Therefore, the null hypothesis was rejected. The nutritional value, measured by TDN%, was not a factor in a firm's decision to purchase feed inputs.

Hypothesis #10: Grain Cost & Nutritional Efficiency (Relates to Questions 3 and 4 of Survey)

Even though corn and wheat are historically higher priced per bushel, they are cost effective feed inputs because the levels of TDN% or ME for all species was higher for corn and wheat than for grain sorghum or barley.

A dollar value was assigned to the TDN% and ME levels in No. 2 yellow corn, No. 2 soft red winter wheat, No. 2 barley, and No. 2 grain sorghum. The price of one percentage of TDN per bushel and the price of 1,000 Kcal/lb. were calculated based on the bid prices of the respondents and the TDN% and ME values for each grain published in the National Research Council's Nutritional Requirements for cattle, swine, and poultry. For most ruminants the TDN% are the same for each grain but the ME levels vary slightly between swine and poultry.

Hypothesis 10: The cost of one percentage of the TDNs in a bushel or 1,000 Kcal/lb. of No. 2 yellow corn, No. 2 red winter wheat, No. 2 Barley, and No. 2 grain sorghum are the same for each species (i.e. the same across all four grains for hogs).

i.e. H_O: $\mu_C = \mu_{WW} = \mu_S = \mu_B = \mu_{GS}$

H_A: Not all of the means are equal.

where: μ_C = mean cost of one percentage of TDNs or ME in one bushel of No. 2 yellow corn.

μ_{WW} = mean cost of one percentage of TDNs or ME in one bushel of No. 2 red soft winter wheat.

μ_S = mean cost of one percentage of TDNs or ME in one bushel of No. 1 soybeans.

μ_B = mean cost of one percentage of TDNs or ME in one bushel of No. 2 barley.

μ_{GS} = mean cost of one percentage of TDNs or ME in one bushel of No. 2 grain sorghum.

Results: Table 2-1 is a summary of the ANOVA done to test the null hypothesis for ruminants, such as beef and dairy cows.

Table 2- 1: Summary of Single Factor ANOVA and Scheffe's test for Hypothesis 10: The Costs of One Percentage of TDN in a Bushel of No.2 Yellow Corn (X_C), No.2 Soft Red Winter Wheat(Xww), No.2 Barley (X_B), and No. 2 Grain Sorghum (X_{GS}) for **Ruminants**

SUMMARY

Groups	*n Value*	*Sum*	*Average*	*Variance*
X_C = $/TDN% Corn	30	8.45	0.28	0.0005
X_{WW} = $/TDN% SRWW	28	6.97	0.25	0.0012
X_B = $/TDN% Barley	30	12.27	0.41	0.0023
X_{GS} = $/TDN% GS	13	3.75	0.29	0.0054

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.4271	3	0.1424	76.9412	1.49E-25	2.6984
Within Groups	0.1795	97	0.0019			
Total	0.6066	100				

Scheffe's Test: Results of Multiple Comparisons.

Contrast (absolute value)			*S Range*		*Significant (yes/no)*
$X_C - X_{WW}$	=	0.033	>	0.0322	Yes
$X_C - X_B$	=	0.127	>	0.0316	Yes
$X_C - X_{GS}$	=	0.007	<	0.0406	No
$X_{WW} - X_B$	=	0.160	>	0.0322	Yes
$X_{WW} - X_{GS}$	=	0.040	<	0.0411	No
$X_B - X_{GS}$	=	0.120	>	0.0406	Yes

The cost of one percentage of TDN per bushel of No. 2 yellow corn, No. 2 red winter wheat, and No. 2 grain sorghum was the same. Only soft red winter wheat was slightly more affordable than yellow corn. The results of Scheffe's test indicates that barley was significantly more expensive than any other type of feed grain (Gorber & Shannon, 1989).

The ANOVA and Scheffe test results for poultry (Table 2-2) indicate that the cost of 1,000 Kcal/lb. of wheat was significantly higher, compared to corn, barley, and grain sorghum.

Table 2 - 2: Summary of Single Factor ANOVA and Scheffe's test for Hypothesis 10:
The Costs of One Percentage of TDN in a Bushel of No.2 Yellow Corn (X_C),
No.2 Soft Red Winter Wheat(Xww), No.2 Barley (X_B), and No. 2 Grain Sorghum (X_{GS}) for **Poultry**

SUMMARY

Groups	*n Value*	*Sum*	*Average*	*Variance*
X_C = $/1,000 Kcal Corn	30	1.0341	0.0345	7.9E-06
X_{ww} =$/1,000 Kcal SRWW	28	1.1856	0.0423	2.62E-05
X_B = $/1,000 Kcal Barley	30	1.0215	0.0341	2.14E-05
X_{GS} = $/1,000 Kcal GS	13	0.4297	0.0331	9.03E-05

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.001411	3	0.0005	17.2819	4.55E-09	2.6984
Within Groups	0.00264	97	2.72E-05			
Total	0.004051	100				

Scheffe's Test: Results of Multiple Comparisons.

Contrast (absolute value)			*S Range*		*Significant (yes/no)*
$X_C - X_{ww}$ = 0.0079		>	0.0037		Yes
$X_C - X_B$ = 0.0004		<	0.0036		No
$X_C - X_{GS}$ = 0.0014		<	0.0047		No
$X_{ww} - X_B$ = 0.0083		>	0.0037		Yes
$X_{ww} - X_{GS}$ = 0.0093		>	0.0047		Yes
$X_B - X_{GS}$ = 0.0010		<	0.0047		No

The ANOVA and Scheffe test results for swine (Table 2-3) indicates that 1,000 Kcal/lb. of barley was more cost efficient compared to corn, soft red winter wheat, and grain sorghum. The Scheffe tests also indicated that compared to grain sorghum, 1,00 Kcal/lb. of soft red winter wheat, was statistically less cost efficient.

Table 2 - 3: Summary of Single Factor ANOVA and Scheffe's test for Hypothesis 10: The Costs of One Percentage of TDN in a Bushel of No.2 Yellow Corn (X_C), No.2 Soft Red Winter Wheat(Xww), No.2 Barley (X_B), and No. 2 Grain Sorghum (X_{GS}) for **Swine**

SUMMARY

Groups	*n Value*	*Sum*	*Average*	*Variance*
X_C = $/1,000 Kcal Corn	30	1.0134	0.0338	7.59E-06
X_{ww} =$/1,000 Kcal SRWW	28	1.0318	0.0369	1.99E-05
X_B = $/1,000 Kcal Barley	30	0.8874	0.0296	1.61E-05
X_{GS} = $/1,000 Kcal GS	13	0.4309	0.0331	9.07E-05

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.0008	3	0.0003	10.8374	3.33E-06	2.6984
Within Groups	0.0023	97	2.38E-05			
Total	0.0031	100				

Scheffe's Test: Results of Multiple Comparisons.

Contrast (absolute value)			*S Range*		*Significant (yes/no)*
$X_C - X_{ww}$ = 0.0031		<	0.00346		No
$X_C - X_B$ = 0.0042		>	0.00340		Yes
$X_C - X_{GS}$ = 0.0006		<	0.00438		No
$X_{ww} - X_B$ = 0.0073		>	0.00346		Yes
$X_{ww} - X_{GS}$ = 0.0037		>	0.00442		Yes
$X_B - X_{GS}$ = 0.0036		>	0.00438		Yes

Section 2.4: Summary of Survey Results

The responses to the survey were used to evaluate the 10 hypotheses regarding the barriers to the expansion of the grain sorghum and barley markets. Table 2-4 and Table 2-5 summarize the results of hypotheses tests 1 through 8 for grain sorghum and barley, respectively.

Table 2- 4: Summary of Results Associated with Grain Sorghum (Hypotheses Tests 1- 8)

Hypothesis	't'-Test Results[1]	Interpretation
Transaction Costs H_O: $\mu_X = 0$ $X = 0.29$	Reject H_O 't' = 2.314 $t_{crit} = 2.160$	Transaction costs are not indicated to be a market barrier.
Marketing Risk H_O: $\mu_C - \mu_{GS} = 0$ $X_C - X_{GS} = 0.13$	Failed to Reject H_O 't' = 0.2995 $t_{crit} = 2.036$	Marketing risks are not indicated to be market barrier.
Price Risk H_O: $\mu_1 - \mu_2 = 0$ $X_1 - X_2 = 23.8$	Failed to Reject H_O 't' = 1.475 $t_{crit} = 2.036$	Price risk (use of futures) is not indicated to be a market barrier.
Spot Prices H_O: $\mu_1 - \mu_2 = 0$ $X_1 - X_2 = 8.1$	Reject H_O 't' = 3.672 $t_{crit} = 2.032$	Bid prices based on given corn prices are indicated to be a barrier.
Market Prices H_O: $\mu1 - \mu2 = 0$ $X_1 - X_2 = -5.02$	Failed to Reject H_O 't' = -0.788 $t_{crit} = 2.179$	Price structure of actual bids are not indicated to be a barrier.
Local Availability H_O: $\mu_X = 0$ $X = 0.875$	Reject H_O 't' = 7.407 $t_{crit} = 2.44$	Local availability is indicated to be a market barrier
Local Use H_O: $\mu_X = 0$ $X = 0.286$	Failed to Reject H_O 't' = 1.55 $t_{crit} = 2.44$	Local use is not indicated to be a market barrier.
Nutritional Value H_O: $\mu_X = 0$ $X = 0.143$	Failed to Reject H_O 't' = 1.01 $t_{crit} = 2.44$	Nutritional value is not indicated to be a market barrier.

[1]Decision Rule: If $t_{calculated} \geq t_{critical}$, reject H_O. If $t_{calculated} < -t_{critical}$, reject H_O. Otherwise accept H_O.

Table 2- 5: Summary of Results Associated with Barley (Hypotheses Tests 1- 8)

Hypothesis	't'-Test Results[1]	Interpretation
Transaction Costs H_O: $\mu_X = 0$ $X = 0.05$	Failed to Reject H_O 't' = 0.950 $t_{crit} = 2.101$	Transaction costs are indicated to be a market barrier.
Marketing Risk H_O: $\mu_{WW} - \mu_B = 0$ $X_{ww} - X_B = -3.2$	Failed to Reject H_O 't' = -0.914 $t_{crit} = -2.045$	Marketing risks are not indicated to be market barrier.
Price Risk H_O: $\mu_1 - \mu_2 = 0$ $X_1 - X_2 = 23.2$	Failed to Reject H_O 't' = 1.435 $t_{crit} = 2.052$	Price risk (use of futures) is not indicated to be a market barrier.
Spot Prices H_O: $\mu_1 - \mu_2 = 0$ $X_1 - X_2 = 12.9$	Reject H_O 't' = 6.252 $t_{crit} = 1.989$	Bid prices based on given corn prices are indicated to be a barrier.
Market Prices H_O: $\mu_1 - \mu_2 = 0$ $X_1 - X_2 = 19.7$	Reject H_O 't' = 13.331 $t_{crit} = 2.059$	Price structure of actual bids is indicated to be a barrier.
Local Availability H_O: $\mu_X = 0$ $X = 0.83$	Reject H_O 't' = 18.993 $t_{crit} = 2.201$	Local availability is indicated to be a market barrier
Local Use H_O: $\mu_X = 0$ $X = 0.50$	Reject H_O 't' = 3.01 $t_{crit} = 2.201$	Local use is indicated to be a market barrier.
Nutritional Value H_O: $\mu_X = 0$ $X = 0.083$	Failed to Reject H_O 't' = 1.0 $t_{crit} = 2.201$	Nutritional value is not indicated to be a market barrier.

[1]Decision Rule: If $t_{calculated} \geq t_{critical}$, reject H_O. If $t_{calculated} < -t_{critical}$, reject H_O. Otherwise accept H_O.

Section 2.4.1: Results Associated with Grain Sorghum (Hypotheses 1-8)

The results of the hypothesis test stated that a significant number of respondents indicted that the transaction costs for grain sorghum were not greater than those associated with corn transactions (see Figure 2-3). Additional information revealed that the increased costs were attributed to special drying equipment.

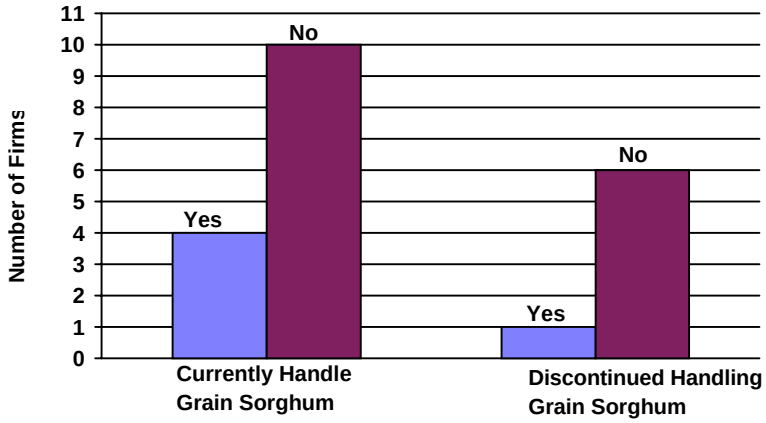


Figure 2-3: Are Transaction Costs for Grain Sorghum > Transaction Costs for Corn?

When the transaction costs were ranked by importance, drying equipment was ranked third compared to marketing information, transportation equipment, contracting, ensuring delivery, bin type, bin loading and unloading equipment, and additional labor.

Only one of the seven firms (Figure 2-3) that discontinued handling grain sorghum felt that the transaction costs associated with handling grain sorghum were greater than the costs associated with corn, and none of the firms indicated that handling costs associated with grain sorghum were a factor in their decision to stop handling the grain.

Hypotheses 2 and 3 attempted to identify overall marketing risk and price risk as market barriers. Respondents identified uncertain prices, uncertain quality, futures market in general, lack of futures for grain sorghum and barley, and unstable demand for grain as sources of increased risk (Figure 2-4). Seven out of twenty respondents identified uncertain grain quality as a source of risk. Four our of the twenty respondents identified the futures market, in general, as a source of risk; while, only one respondent identified the lack of grain sorghum and barley futures as a source of risk. Three respondents listed market uncertainty, two listed uncertain prices, and one listed storage facilities as sources of risk in the Virginia grain market.

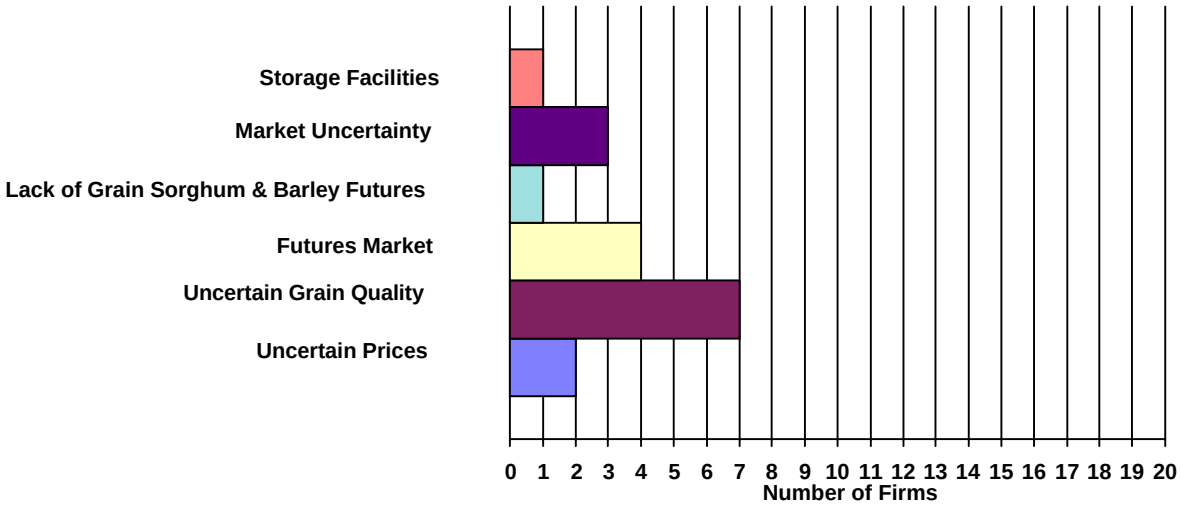


Figure 2-4: Sources of Risk Identified by Survey Respondents

Figure 2-5, illustrates the distribution of ranks assigned to yellow corn and grain sorghum. When the mean rank for the risk associated with the marketing activities of grain sorghum and corn were compared (Hypothesis 2), there was no statistical difference between the two means; therefore, overall marketing risk was not a market barrier.

The distribution of the ranking associated with marketing activity for the firms who no longer handle grain sorghum, illustrated by Figure 2-6, supports the interpretation that marketing risks may not act as a barrier to the expansion of the grain sorghum market. In addition, none of the first level handlers who had discontinued buying and selling grain sorghum agreed with the statement that the risk associated with marketing grain sorghum was a factor in the firm's decision to discontinue handling the grain.

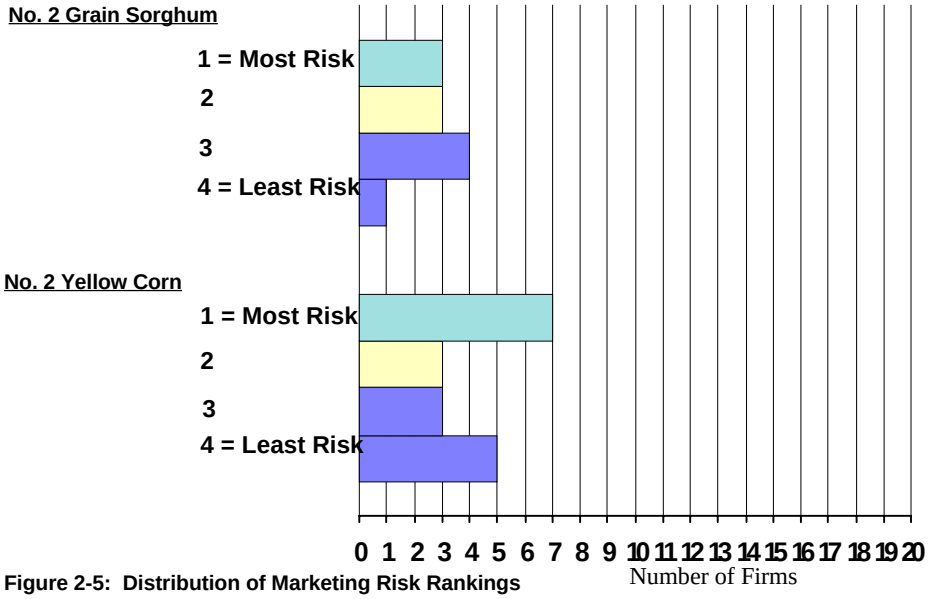


Figure 2-5: Distribution of Marketing Risk Rankings Associated with Grain Sorghum & Yellow Corn

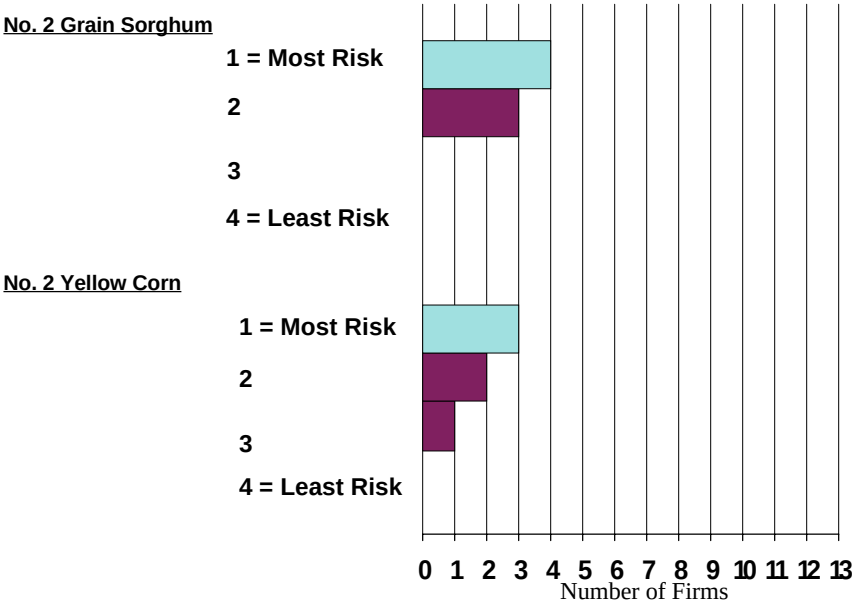


Figure 2-6: Distribution of Marketing Risk Ranking Associated with Grain Sorghum & Yellow Corn for Fims who Doscontinued Handling Grain Sorghum

Hypothesis 3 focuses on the risk associated with price. The statistical analysis indicated that there was no significant difference between the sample means of a firm's market activity for corn covered by cash and all forward contracts and futures and options on futures, indicating that price risk was not a market barrier.

Hypothesis 4 compares the mean spot price of No. 2 grain sorghum as a percentage of the given spot price for No. 2 yellow corn to the feed value of grain sorghum. The results of the t-test led to the rejection of H_O, indicating that the two sample means were significantly different. According to the sample means, the average spot price of grain sorghum, based on a given spot price of corn, was 86.9% of the given price of corn.

Hypothesis 5 was set up to test whether the relationship between prices and feed values are reflected in firms' bid prices. The feed value for grain sorghum was compared to the firm's average bid price for grain sorghum (expressed as a percentage of the firm's average bid price for corn). The mean bid price of grain sorghum expressed as a percentage of the bid price of corn was 100.1%, which was statistically equivalent 94% (grain sorghum's feed value).[1]

Hypotheses 6, 7, and 8 evaluate the reasons why first level handlers discontinued handling grain sorghum. Each firm was asked if they agreed with the following statements: (1) the lack of local supply was a factor in the decision to stop handling grain sorghum; (2) the demand for the grain as a feed source was a factor in the decision to stop handling grain sorghum; and (3) the nutritional content was a factor in the decision to stop handling grain sorghum. Hypothesis 6, was the only hypothesis rejected because a significant number of firms agreed with statement 1. Figure 2-7, shows the frequencies of the responses of firms that discontinued handling grain sorghum.

[1]Numerically 89.9% and 100.1% appear to be different from 94%, creating the expectation that the results of tests 4 and 5 should be the same. However, the results of the hypotheses tests are based on samples size and the resulting t-values. The sample sizes used to test hypothesis 4 and 5 were different, resulting in different t-values (calculated and critical)and different results for each test.

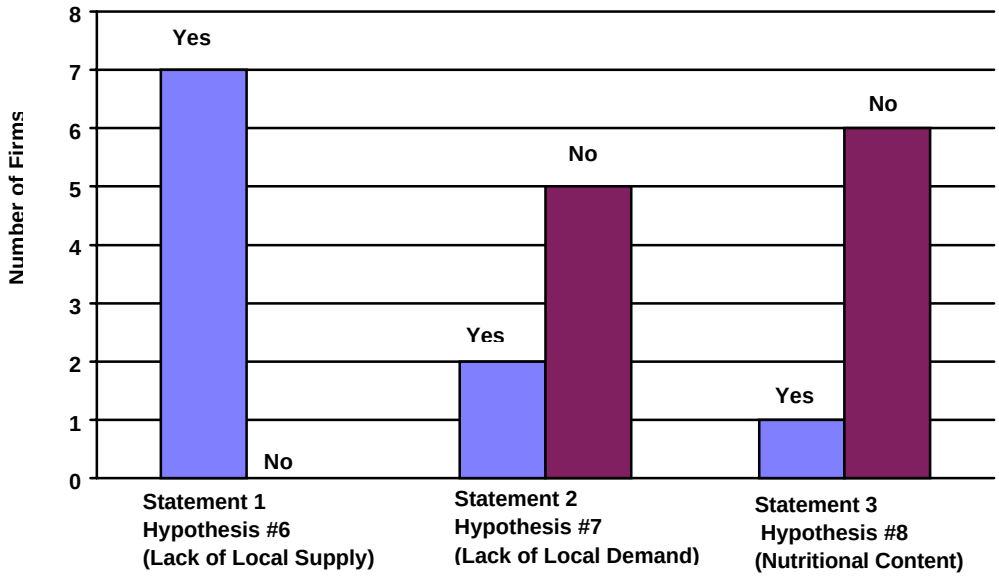


Figure 2-7: Responses of Firms who Discontinued the Handling of Grain Sorghum

Section 2.4.2: Results Associated with Barley (Hypotheses 1-8)

The same eight hypotheses tests were performed on data concerning barley. In the first three hypotheses barley was compared to wheat because they considered decision making related to handling the grains. Hypotheses 4 and 5 compared barley prices to corn prices because they considered decision making related to marketing influences associated with the Virginia grain market. Unlike grain sorghum and corn, the transaction costs associated with No. 2 barley were greater than the transaction costs associated with No. 2 soft red winter wheat. Eighteen out of the nineteen respondents indicated that the transaction costs associated with barley were greater than the transaction costs associated with winter wheat.

The risk associated with overall marketing activities (Hypothesis #2) and price (Hypothesis #3) were not significant barriers to the expansion of the barley markets in Virginia. Figure 2-8 illustrates the distribution of ranking associated with the marketing risk for soft red winter wheat and barley. The result of the statistical analyisis of Hypothesis #3 for barley stated that there was no significant difference between the sample means of a firm's market activity for winter wheat covered by cash and all forward contracts and futures and options on futures.

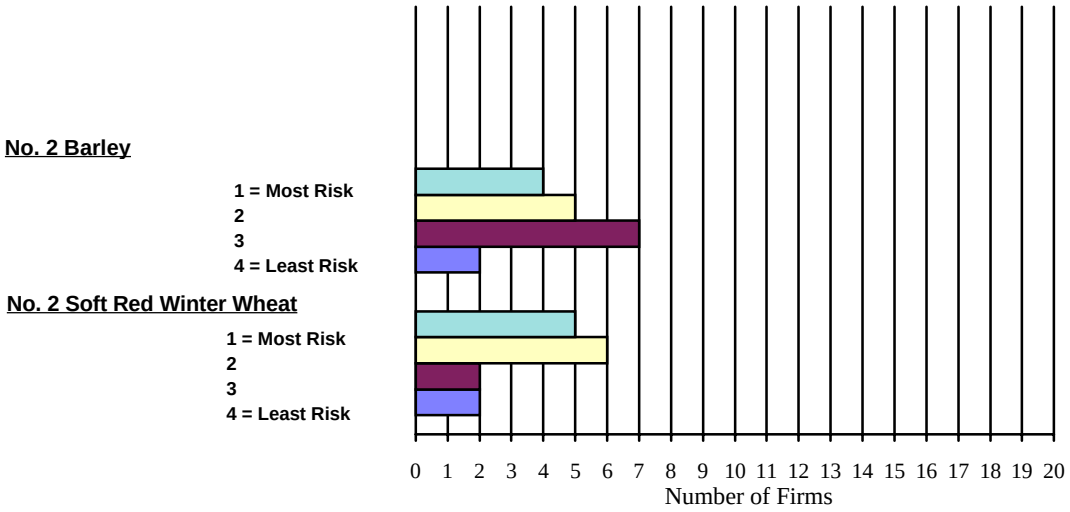


Figure 2- 8: Distribution of Marketing Risk Rankings Associated with Barley & Soft Red Winter Wheat

The survey results indicated that overall marketing risk between alternative crops (i.e. grain sorghum and corn or barley and wheat) were not statistically different. Because the calculated F was less than F_{crit}, the perceived overall risk associated with handling any specified grain was not statistically different from the risk associated with any of the other three grains.

Based on the frequency of responses, first level handlers found the overall marketing risk associated with corn and wheat to be greater than the risk associated with grain sorghum and barley (see Table 2-6).

Table 2-6: Mode Rank Associated with Overall Marketing Risk

	Mode Rank
No. 2 Yellow Corn	**1**
No. 2 Soft Red Winter Wheat	**2**
No. 2 Grain Sorghum	**3**
No. 2 Barley	**3**

The mean spot price of No. 2 barley as a percentage of the given spot price of No. 2 yellow corn and the firm's mean bid price of barley as a percentage of their bid price for corn were significantly lower than the National Research Center's feed value for barley (84%). Hypotheses 4 and 5 were rejected because barley prices, expressed as a percentage of corn prices, were statistically different from barley's feed value, in corn equivalents. When the bid price of No. 2 barley is compared to the bid price of No. 2 soft red winter wheat, the sample means indicate that the price of barley is less than 57% of the price of soft red winter wheat.

The t-tests for hypothesis 6, 7, and 8, resulted in the rejection of the null hypotheses in 6 and 7. The lack of locally supplied barley and the demand for barley as a feed source were both factors in first level handlers' decision to discontinue handling the grain. All of the firms who felt

that the demand for barley was a decision making factor, ranked it second in importance to the lack of local gain supply. Only one firm who agreed that demand was a factor that contributed to their decision also agreed that the nutritional content of barley was a factor in their decision.

Section 2.4.3: Results Associated with Nutritional Considerations (Hypotheses 9 & 10)

Hypothesis 9 tests whether feedmills consider the nutritional values of the grain they handle. Approximately 55% of the feedmills included in the survey consider total digestible nutrients (TDN) or metabolizable energy (ME) levels when making purchasing decisions. Based on statistical analysis, a significant number of feedmills consider the nutritional level of the grain to be a factor when making a purchasing decision.

The combined results of the ANOVA and the Scheffe's test in hypothesis 10, identifies substitutable feed inputs for each species. The ANOVA and the Scheffe's test results indicated that when feeding ruminants, barley was significantly different in value compared to any other type of feed and was a less suitable substitute. Based on the costs of 1,000 Kcal/lb. of ME, the ANOVA and Scheffe test results for poultry indicated that wheat was significantly different in value compared to corn, barley, and grain sorghum and was a less suitable substitute.

The ANOVA and Scheffe test results for swine indicated that compared to barley, 1,000 Kcal/lb. of ME for corn, soft red winter wheat, and grain sorghum are statistically different in value. Therefore, based on prices and nutritional levels, barley was found to be the most substitutable feed input for swine.

Section 2.5: Conclusions Based on Survey Results

The primary barrier to the development of the grain sorghum and barley markets identified in the survey was the lack of a consistent local supply. This factor contributed to firms' decisions to discontinue handling these grains and was considered to be the source of increased risk associated with marketing the alternative crops. A study concerning the development of grain sorghum in the Philippines came to a similar conclusion. Feedmillers in the Philippines identified the unreliability of supply as the crops main draw back, and the researcher went on to conclude that a break in the continuity of supply disrupted feedmillers' ration planning, and further discouraged the inclusion of sorghum as a feed component. "The resulting decrease in demand led to a [continuous] sharp decline in supply. This self-reinforcing spiral all but eliminated the sorghum sector' (Brion, 1996).

The barriers that were expected, *a priori*, to be the greatest obstacle to the expansion of the grain sorghum and barley markets were not statistically proven to act as market barriers. Transaction costs were not an issue for a significant number of firms who handle grain sorghum.

According to the hypothesis tests, a significant number of firms who handle grain sorghum found transaction costs associated with grain sorghum are not greater than corn's costs.

The risk associated with handling grain sorghum (barley) did not outweigh the risk associated with corn (wheat), despite the fact that corn and wheat had established markets in Virginia. Contrary to *a priori* expectations, according to survey results, first level handlers indicated that the overall marketing risk associated with the two established grains was greater than the risk associated with the suggested alternative grains. Surprisingly, comparing the mean overall rankings of all four grains did not result in any grain being statistically more risky compared to any of the substitutes. The frequency of responses indicated that No. 2 yellow corn would be considered most risky, No. 2 soft red winter wheat would be second, and No. 2 grain sorghum and No. 2 barley are the least risky.

The study was designed to test industry perceptions that changes in the existing infrastructure would be required if grain sorghum and barley were to expand their share of the Virginia grain market. It was assumed, *a priori*, that components of the existing infrastructure were sources of increased risk. However, only one respondent indicated that storage facilities, a component of the physical infrastructure, were a source of increased risk. The futures market, a component of the marketing infrastructure, was also assumed to be a source of risk but only four respondents indicated that this was the case. One substantial and unexpected result was the that fact that the lack of futures for grain sorghum and barley is not perceived by first-level handlers as a source of increased risk.

The availability of futures, and options on futures, as tools to manage price risk associated with corn and wheat did not make these grains more attractive to first level handlers. There was no indication from the survey responses that the presence of futures and options lessened the price risk associated with corn and wheat. In fact, for the average Virginia firm, 38% of their corn transactions and 39% of their wheat transactions were covered by futures, and options on futures. Therefore, the absence of futures for grain sorghum and barley should not be a major constraint to development of the grain sorghum and barley market in Virginia.

Uncertainty regarding quality and prices were also considered, *a priori*, to be significant market barriers to the expansion of grain sorghum and barley in Virginia. However, overall market uncertainty, was only identified by three of the twenty respondents to be a source of increased risk for grain sorghum and barley. Only two respondents felt that price uncertainty was a source of increased risk, while seven respondents perceived uncertainty regarding the quality of grain as a source of increased risk. Because it is the grain producers, not the first-level handlers, who are the price takers in the grain market in Virginia, first-level handlers may not feel uncertainty is a factor of increased risk. The first level handlers can compensate for increased levels of uncertainty by decreasing what they are willing to pay for grain sorghum or barley. First-level handlers could increase the their expected marketing margins; therefore, transferring the risk associated with the grain onto the second-level handlers or down to the farm level. Their ability to transfer expected risk to grain producers is indicated by first-level handlers' bid prices for grain sorghum and barley. The bid prices for both grains were below the grains national value when first-level handlers were asked for their spot price, given the spot price for corn.

Price appears to be the second most important market barrier, especially for barley. The bid prices of corn (mid-April 1995 and mid-September 1995) and wheat (mid-September 1994 and mid-June 1995) were significantly higher than the price of barley (mid-September 1994 and mid-June 1995), providing little incentive for producers to substitute wheat production with barley production. Therefore, two reasons for the lack of production are: (1) price bids send a signal to barley producers that they are not being compensated for the quality of their crop; and (2) the opportunity costs of forgoing wheat production outweigh the potential gains from barley production. This conclusion adds strength to the argument that the barley market remains underdeveloped in Virginia because producers are not compensated for the full value of the crop. The expansion of the barley market will rely on the ability of barley to compete as an affordable source of feed. It will take an increase in the demand for barley as a feed input to apply the upward pressure on farm prices.

Based on 1995 bid prices and the grain's nutritional content, barley is an economically viable substitute for poultry feed, compared to soft red winter wheat, and yellow corn. The greatest potential for expansion of the barley market is as swine feed. The value of ME from barley is significantly different than the ME from any of the other grains considered in this study, and more cost efficient.

In the case of grain sorghum, the price signals provided by first level firms may be a source of confusion. In the survey the firms were asked for the bid price for grain sorghum and corn at planting and harvest in 1995. The average quoted bid price for grain sorghum was equivalent to the average quoted bid price for yellow corn. According to the survey, the actual bid prices were fully compensating producers for the feed value of grain sorghum, and should not constrain the expansion of grain sorghum in Virginia. However, when asked for their spot price for grain sorghum, given the spot price for corn, first handlers' prices for grain sorghum averaged 86.9% of the price of corn. Because of the lack of historical price information for grain sorghum, it is likely that producers base planting decisions' on the first level handlers bid quotes at planting time. The lack of information regarding prices may be contributing to the lack of locally produced grain sorghum.

Based on the 1995 bid prices of survey respondents, grain sorghum also proved to be an economically viable feed input for swine and poultry. In the state of Virginia, based on 1995 bid prices and the grain's nutritional content, grain sorghum is an economically viable substitute for soft red winter wheat, and yellow corn as a feed input for swine and poultry. Therefore, the characteristics desired by livestock and poultry producers probably do not constrain the expansion of grain sorghum and barley. These characteristics may provide the incentive to expand the grain sorghum and barley industries in Virginia.

The survey results did not indicate that the existing structure of the Virginia grain industry favored established grains, such as yellow corn and soft red winter wheat. The only advantage is in the perceived uncertainty with respect to grain sorghum and barley. First level firms can create reasonable expectations regarding the availability and the quality of Virginia corn and wheat, as well as, the demand for the grains at the next level in the marketing system. A feedmill must have

the ability to control the quality and ration consistency. Failure to accurately forecast available supplies can lead to a shortage of ration ingredients and result in lower quality feed mixtures (Richardson, 1990). Feed processors are unlikely to increase their demand for grain sorghum and barley until the uncertainty surrounding the supply of Virginia small grains is removed.

The results of the study imply that the lack of a consistent local supply of grain sorghum and barley is the major constraint to the expansion of these crops. The limited supply has contributed to the uncertainty surrounding the reliability of local grain sorghum and barley, as well as to the limited demand at the second-handler level. In order to improve the local supply situation, grain sorghum and barley producers would have to be provided with an incentive to divert acreage to grain sorghum and barley production. Producers' expectations regarding the net return on substituting grain sorghum and barley acreage in their crop mixes would have to be greater than the expected net return on current crop mixes. If demand for grain sorghum and barley as a feedsource were to increase and resulted in higher farm prices, then producers would have an economic incentive to increase the local supply of these grains. Herein lies the problem, based on this study's results, it appears that there will not be an incentive to increase local supply without increasing local demand, and there will not be an incentive to increase local demand without increasing local supply. Therefore, expanding the market share of grain sorghum and barley in Virginia may be influenced by a number of factors, including (1) efforts to educate livestock and poultry producers on the cost saving ability of these grains; or (2) the feasibility of developing a vertically integrated system between grain producers, feedmills, and livestock and poultry producers, through developing partnerships, or new methods of contracting for grain.