PROGRAM ATTRIBUTES THAT IMPACT A FARMERS WILLINGNESS-TO-ACCEPT PARTICIPATION IN A HIGH OLEIC SOYBEAN (HOS) SEGREGATION PROGRAM: A CHOICE EXPERIMENT

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Approval Page

Those undersigned were appointed by the dean of the Graduate School and have examined the thesis entitled:

PROGRAM ATTRIBUTES THAT IMPACT A FARMERS WILLINGNESS-TO-ACCEPT PARTICIPATION IN A HIGH OLEIC SOYBEAN (HOS) SEGREGATION PROGRAM: A CHOICE EXPERIMENT

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become closer because you all truly are the world to me. Words can't describe how proud I is to be part of the family. Let's continue making memorable, happy life experiences. We certainly have many excellent memories to think back on!

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ABSTRACT

High oleic soybeans (HOS) are soybeans recently developed to improve the fatty acid profile of soybeans oils in order to make them healthier for human consumption and more cost effective to process. HOS need to be segregated from commodity grain at the farm and through the rest of the food chain so that high oleic soybeans and oils do not get commingled with their bulk counterpart. Production at the farm is typically governed by contractual arrangements between farmers and buyers of HOS to make certain that famers implement adequate segregation measures during production, storage and transportation.

A few of this high oleic soybean programs have been put in place last years in restricted location of the United Stated Midwest. These programs are likely to expend in the future, but little is currently known about the constraint and factors influencing farmers' participation HOS programs. The aim of thesis is to provide information about grower preferences for the key contracts attributes used in governing the production of HOS soybeans. These attributes are premium levels, delivery windows, distance to buyer, thresholds and HOS brand names.

The methodology consisted of a choice experiment survey administered to a random sample of growers over the internet. Results indicated that premium levels, delivery options and the distance to buyer are attributes that significantly influence growers' willingness to participate in HOS programs. In particular, growers are

willing-to-accept (WTA) about $0.12/bushel less of a premium if a harvest delivery (HD) option rather than a buyer's call (BC) delivery option is given.

1. Introduction

Contract arrangements for the production of high oleic soybeans (HOS) are likely to play a significant role in the adoption of these varieties of soybeans. Indeed, contracts allocate the value share, decision rights and uncertainties linked to the transaction between buyer and seller of specialty crops (Sykuta & Parcell, 2003). Contracts have been used extensively in agriculture either as simple arrangements to specify the grades and prices for spot marketing (Goldsmith, 2004) or for more elaborate transactions for which marketing contracts are typically used.

James, Klein, & Sykuta (2011) classify marketing contracts as agreements where production practices are decided upon by the growers. Marketing contracts are therefore contracts that are typically used for the production of specialty crops which often require some degree of control by the buyers over production. Transactions involving row crops comprised the largest share (roughly 66 percent) of agricultural marketing contracts in 2008 (MacDonald & Korb, 2008) and in 2005 approximately 22 percent of total agricultural production was traded through the use of marketing contracts (MacDonald & Korb, 2008). These contracts nearly always contain a delivery schedule, a delivery location, quantity and pricing terms.

Crop segregation programs, such as HOS program, involve commodities that do not display a high degree of differentiation and do not need to be strictly identity preserved as would be the case for non genetically modified (NGM) crops. As a result, contracts used for these programs typically do not specify a set of steps or tasks that producers would have to comply to during the planting and growing season. However, they often specify a certain level of purity threshold that must be maintained, i.e. the maximum percentage of contamination from unlike crops which a batch of segregated/identity preserved (IP) grain may contain.

The contracts that are used for HOS segregation programs specify the seed varieties to be planted, the delivery option, premiums per bushel, other pricing terms, contingencies, threshold/IP requirements, and delivery location. An incentive premium is given to offset additional segregation costs growers may incur because of the constraints associated with participating in the segregation program. Many costs must indeed be incurred by grower participating in these programs because the contract attributes constrain farm management practices.

Additional segregation costs are also incurred by different parties across the corresponding supply chain, however, the segment of the overall HOS supply chain relevant for this thesis consists of only three steps. The first step in the segment of the HOS supply chain analyzed in this thesis consists of the farm and fields of the growers participating in the program. Second, at some time after harvest the crop is supplied to an intermediary buyer. Third, HOS batches are sent to a soybean processing (crushing) facility where HOS oil is extracted. Figure 1 illustrates the chain and the following section characterizes additional segregation costs which participants may encounter.

Map 1 Basic HOS Supply Chain

A. Segregation Costs at Processes of the HOS Supply Chain

Segregation costs are additional costs that growers realize when participating in a segregation program. The different segregation costs that growers much incur during the growing season can be classified into different categories. The first category consists of coordination cost and includes searching and bargaining costs as well as contract construction costs. Coordination costs have been depicted as beginning before planting and accruing until the end user takes possession of the crop (Maltsbarger & Kalaitzandonakes, 2001). The second category consists of the monitoring costs which begin shortly after a grower has chosen to participate in a program. The monitoring costs are related to the amount of labor necessary to determine whether segregation responsibilities are being upheld by the grower. The third type of segregation costs are extra cleaning costs as the growers and the buyers are expected to keep equipment clean. Maltsbarger & Kalaitzandonakes (2001) note that extra cleaning of equipment – e.g. tractors, trucks and on-farm capacity – has to be thoroughly done by growers to prevent co-mingling of segregated crops with bulk commodities. The last category of segregation costs consists of the opportunity costs which are only incurred indirectly by growers. For example, growers are sometimes compelled to plant a buffer zone around in the fields whose crop has been contracted. A buffer zone is land required to be used (or idled) in a pre-determined way to prevent cross pollination. Not all segregation programs require buffer zones. But those that do limit the number of cropland management opportunities a grower may choose to undertake while utilizing his/her land resources for utility maximization and therefore costs are only incurred indirectly.

After harvest a grower transports grain to the first point of delivery (FPD) which is often dictated by a program attribute indicating the type of delivery option (Maltsbarger, 1999). If the FPD is the growers own capacity, as in a scenario characterized by a buyers call (BC) delivery option, the farm business incurs a storage cost of about $0.03/bushel/month (Thakur & Hurburgh, 2009). The BC delivery option implies the transaction and physical movement of grain from grower to buyer will not occur until a specified timeframe months after soybean harvest. During this timeframe (ex: Feb-March 2015) the buyer will call in the grower to deliver the crop. In this BC scenario, if a grower would have preferred to deliver grain to a buyer immediately after harvest (as is implied by the harvest delivery option) then the additional travel distance, storage cost and any other opportunity costs should also be counted as segregation cost.

Batches of segregated grain eventually travel to an intermediary buyer where additional costs may eventually be incurred by both the growers and the buyers. Batches are typically tested for purity when buyers receive the crops so a fixed cost must be allocated to pay for the testing devices or machines. Variable costs must also be incurred if individual testing kit is used and time must be spent to administer the tests (Wilson, Henry, & Dahl, 2008). Tests may not output accurate information and in this situation misreading costs are accrued to both the grower and the buyer which in essence reduces the transaction efficiency (Gloy & Dooley, 2003). If segregated crop batches do not pass threshold tests, growers incur some cost because they either are paid a discounted price or have to use additional fuel for delivery elsewhere.

If a batch of grain has passed across a buyers scale it will travel to a pit where it is unloaded. Grain bins contain "dump pits, boots, legs, dryers, conveyor belts and spouts" (Bullock & Desquilbet, 2002) which must all be cleaned before the delivery of the specialty crop. Additional storage capacity may have to be build or entire dedicated storage facility may have to be used for very stringent purity thresholds.

Other opportunity costs are relevant for buyer (Maltsbarger, 1999). Elevator makes most of their money by holding grain or rotating grain as often as possible through storage capacity. However, participation in a segregation program may reduce the utilization of the storage capacity when specific bins have to be allocated to segregated crops. This is a potential cost if not planned for accordingly because it implies than normal operations cannot be ran as efficiently (Maltsbarger & Kalaitzandonakes, 2001).

Quantity terms manage yield uncertainty and allow buyers to better predict the amount of in-coming bushels of a segregated crop to expect (Sykuta & Parcell, 2003). The terms depict a specific yield or the entire yield from a specified number of acres to be delivered to buyer (Sykuta & Parcell, 2003). When a precise yield is agreed upon an ex-ante production level is set. Yield contracts allocate risk to growers (Sykuta & Parcell, 2003) because growers will have to buy and deliver additional production if they are short on yield. An acreage term is where 100 percent of the yield from a specified number of acres (ex: 100 acres) is to be transacted. Compared to yield contracts, less risk is allocated to a grower when an acreage contract is agreed upon by a grower and a buyer (Sykuta & Parcell, 2003) because producers will not have to take remedy actions if they are short on yield.

The third and final process comprising the supply chain being studied is the soybean crushing facility. Crushers receive many batches of soybeans, which are then processed into separate byproducts like soybean oil and meal. Additional value these facilities collect from HOS oil transactions needs to be re-allocated back upstream to growers as incentive for planting HOS varieties. The following section details supply and demand of soybean oil.

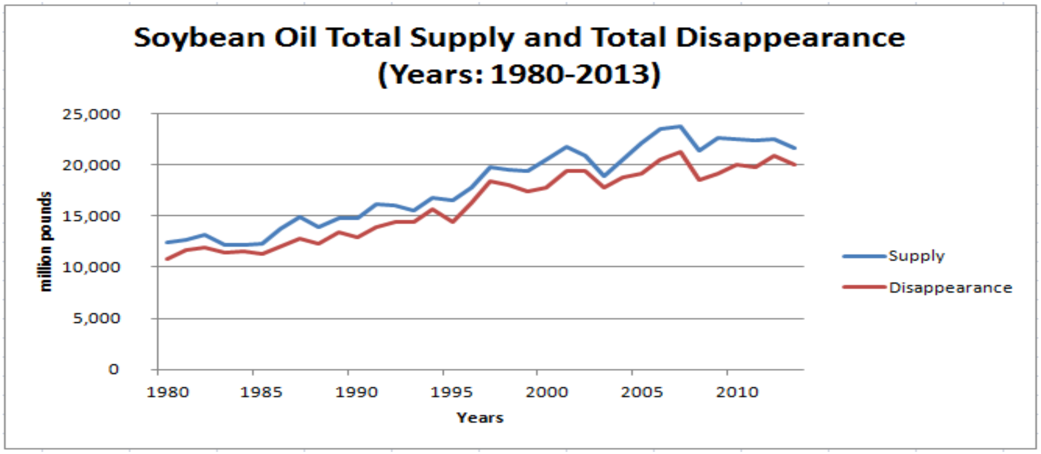
B. Supply and Demand of Soybean Oil

Soybeans account for nearly 90% of oilseed production in the United States ("Soybeans & Oil Crops Overview," 2012). Approximately 85% of the soybean production around the world is crushed into soybean oil and meal, which are separate byproducts used to meet various demands ("Soy Facts," 2014). Soybean oils account for the largest share (approx. 60%) of edible vegetable oils consumed in the United States ("Soybean Oil Uses & Overview," 2014).

Soybean oils are used extensively for food and industrial purposes. About 95% of soybean oil consumed is in the form of human food products ("Soy Facts," 2014). Soybean oil is used in salad dressings, baked goods, crackers, barbecue sauces, various shortenings, imitation dairy products, potato chips, mayonnaise, breads and whipped creams (Cahoon, 2003). The remaining 5% of total consumption is used for industrial purposes; including, inks, paints, varnishes, resins, plastics, animal feeds, automotive oils, other lubricants (not including automotive oils) and biodiesels (Cahoon, 2003).

Figure 1 depicts the total supply and the total disappearance of soybean oil. The market for soybean oil is highly efficient and the total supply (blue line) and the total disappearance (red line) trends move together over time. The total supply (blue line) of soybean oil grew from 12,480 million pounds in 1980 to 21,625 million pounds in 2013. The 2006 supply level was 23,536 million pounds. The difference between the 2006 and 2013 total supply levels was -1,911 million pounds. The total disappearance of soybean oil increased from 10,744 million pounds in 1980 to 20,050 million pounds in 2013. In 2006 the total disappearance of soybean oil was 19,649 million pounds. The difference between the 2006 and 2013 total disappearance levels was -401 million pounds. These decreased levels of both the total supply and the total disappearance of soybean oil, since 2006[1], is a problem this thesis is designed to address by researching how best to get HOS programs adopted by the soybean growers.

Figure 1: Soybean Oil Trends Prior To and After 2006 Trans Fats Regulation



Source: (USDA, 2014)

Approximately 85% of soybean oil in any given year undergoes hydrogenation, which is an industrial process aimed at improving the oxidative stability of oils when they are heated but causes trans fats which are detrimental for human health ("Soy Facts," 2014). Prior to hydrogenation, a batch of soybean oil is a hydrocarbon structure with many carbon double bonds (C=C). During hydrogenation, gaseous hydrogen H is applied across oil sources, the outcome being more C-H bonds and fewer C=C. Partial hydrogenation of soybean oil occurs when not all the carbon double bonds comprising the hydrocarbon structure turn into a C-H connection. Partial hydrogenation is the cause of trans fats, which have been

[1] See: Chapter 1. Section C "Trans fats and Demand Implications for Commodity Soybeans" for more information about the 2006 trans fats labeling law, which has influenced supply of soybean oil.

recently regulated and a decreased rate of soybean oil consumption has occurred since 2006.

C. Trans fats and Demand Implications for Commodity Soybeans

In 1999 the Food and Drug Administration (FDA) proposed regulation of trans fats. The organization estimated that the required labeling of trans fatty acids would result in between 600 to 1,200 fewer cases of coronary heart disease per year, between 240 to 480 fewer human deaths a year and between $900 million to 1,800 million savings in medical expenses each year (Moss, 2006). Regulatory policy eventually passed in January 2006 at the federal level and mandatory labeling of trans fats became a requirement of food manufacturers, bakeries and foodservice providers. The 2006 regulation states that foods must contain fewer than 0.5 grams of trans fats in order to be considered or labeled "0 grams Trans Fat." Commodity soybean oil cannot be labeled with this statement when they have been partially hydrogenated.

Since 2006 more local US governments and international nations have imposed stricter regulation of trans fats; for instance, New York City and Philadelphia are both cities that have banned trans fats consumption in restaurants. Argentina, Australia, Brazil, Canada, Iceland, Switzerland, and the European Union countries have trans fats regulation and several of these nations outlaw its consumption. One reason why supply and total disappearance trends for commodity soybean oils have been declining is most likely because of the trans fats regulation.

D. Benefits of HOS/HOS oil

High oleic soybean varieties were genetically engineered to produce healthier oil than commodity soybeans. High oleic soybean varieties produce oil allowing for benefits similar to those received from commodity soybean oil but do not need to undergo the hydrogenation process to preserve its stability. HOS oil is trans fats free and it reduces marketing and health problems coupled with commodity soybean oils and hydrogenated soybean oils. HOS oil can be labeled with "0 grams Trans-fat," the oil has the lowest amounts of saturated fat compared to any commodity soybean oil, it has great heat and oxidative stability and is heart healthy. These facts show how negative health effects caused by consumption of hydrogenated commodity soybean oils are reduced by production of HOS oil. Furthermore, HOS oil displays great stability when heated.

Commodity soybeans and HOS's contain different levels and combinations of fatty acids. Two types of fatty acids are oleic and linoleic acids. Oleic acid is healthier than linoleic acid. Regular commodity soybean varieties consist of approximately 20% oleic acid and 55% linoleic acid, but this differs across soybean varieties and soybean breeders exploited this variation in the late 1990s. Soybean breeders selected varieties producing high levels of oleic acid and low levels of linoleic acid and reproduced them over generations until a desired outcome of about 75% oleic acid and 3% linoleic acid content was achieved in the mid-1990s.

However, these high oleic soybean (HOS) varieties were not adopted by growers because of a significant yield drag. A few biotechnology companies invested in research project to address this low yield problem and this resulted in development of biotech soybean varieties allowing HOS's to yield comparably with conventional soybean varieties (approximately 50 bushels/acre).

Map 2 The Geography of High Oleic Soybeans

Currently, HOS varieties are being marketed as branded seed and are grown in Indiana, Michigan, Ohio and a small geographical area in Maryland, as depicted by Map 2. The geography that is colored red on Map 2 gives an understanding of where HOS production acreage may have been, during the 2014-15 growing season. There is one buyer in Salisbury, Maryland and so the corresponding amount of red color can be used as an approximate scale. Soybeans are grown in about thirty states but HOS were planted in less than five during the 2014-15 growing season.

Plenish® is the brand name for Pioneer-DuPont's HOS lineup and Vistive Gold® is Monsanto Company's brand name for its HOS varieties. HOS yield the same when compared with conventional soybean varieties in the field and upon oil extraction. Any soybean type consists of about 19-20% oil. A bushel of soybeans weighs 60 pounds (lbs), so a bushel of soybeans yields about 12 lbs of oil.

E. Contract Construction and Adoption Problems

HOS oil may solve some problems encountered with commodity soybean oil, but its production implies contractual and participation issues. Growers currently not participating in a program will need to change some of their management practices to incorporate HOS varieties into their crop rotations. These changes can be inferred from the requirements imposed by HOS segregation programs as shown in Table 1 on the following page.

Contractual requirements can be classified into six different types of attributes. The first one called "Details and Requirements of the Contract" contains attributes important to the discussion. Threshold requirements are required through the use of the phrase identity preserved acreage contract. The premium level is another attribute found in the category. Also, the delivery option is detailed as the agreement for buyer's call, which forces a grower to maintain property rights of HOS's until a specified timeframe; for example, Feb-March 2014. This timeframe is found in the second category "Marketing/Delivery Options Stated." The category known as "High Oleic Soybean varieties to Plant" includes HOS brands and specific seed types available upon participation in a program. The last two categories contain contact information about the buyer and the seed provider. A grower may use this information to determine a field's distance to buyer. Various levels of these attributes can be found across the HOS programs that are currently implemented.

Table 1 Example HOS Program

Category of Attributes	Program Attributes
A. Details and Requirements of the Contract	1. Identity preserved acreage contract with (SEED PROVIDER) and delivery to (BUYER). See separate document for IP details. 2. First-point delivery (ex: On-Farm storage). 3. (SEED PROVIDERS) *high oleic soybeans* must be identity preserved. 4. Premium level (ex: $.50/bushel) for On-Farm storage because of buyers call (BC) delivery.
B. Marketing/Delivery Options Stated	1. Delivery option (ex: Buyers call (BC)). 2. Delivery to (Buyer) is BC from Feb-March 2014. 3. Grain supply contract between BUYER and GROWER with Premium level paid upon settlement.
C. Soybean Quality Characteristics	1. Standard discounts and delivery parameters for crop quality and moisture upon delivery. 2. Moisture Content (ex: 15% maximum)
D. High Oleic Soybean varieties to Plant	1. Branded HOS variety A with (RR) and (Y) traits. Note this is an ex.. 2. Branded HOS variety B with (RR) and (Y) and (X) traits. Note also ex.. 3. Branded HOS variety C with (RR) and (Z) and (Y) traits. Note also ex..
E. Buyers Contact Info	1. BUYER Grain Merchandiser: Jeff Snyder, Phone 800-XXX-XXXX
F. Seed Provider Info	1. SEED PROVIDER REP: Luke Avery, Phone 515-XXX-XXXX

At this point, no studies have sought to investigate grower preferences for HOS program attributes so this thesis aims to fill this void. Information detailing how grower's weight attributes and a grower's preferences of attribute levels would provide contract designers with relevant knowledge. Furthermore, the thesis provides information about contract construction issues and directly encourages an optimal level of HOS adoption because transaction costs would be reduced if information is implemented appropriately by parties.

It is likely that less than 3% of soybean production acreage will be planted with HOS's so the acreage planted to HOS varieties will be relatively small in 2014-15. However, realizing a higher adoption level has been made a priority by the United Soybean Board which works with growers by investigating ways to increase value from production of soybeans. The "checkoff" goal, as indicated by the United Soybean Board, is for 18-23 million planted acres (roughly 810 million bushels) of HOS to be planted by 2023 ("High Oleic Soy," 2013).

F. Research questions and objectives

These problems addressed in the previous section raise several important questions: What attributes cause a decrease/increase in a grower's willingness-to-accept participation in a HOS segregation program? At what levels should these attributes be presented to growers for a most efficient transaction and optimal adoption? How is a grower's willingness-to-accept participation in a HOS segregation program influenced if different choices and combinations of contract attributes are given? How do growers value HOS program attributes? What effect do various combinations of HOS contract attributes have on a farm business and decision making?

These questions relate to adoption and best contract structuring issues. HOS segregation programs can be used to influence HOS production. By critically assessing how growers react to terms found within program, stakeholders will benefit because insights allow for a healthier soybean oil to be diffused across markets over time. Furthermore, the analysis is important because much research expenditure has been put into developing HOS biotech varieties. Pioneer-Dupont spent several decades researching and developing HOS varieties prior to when Plenish® HOS brand seeds entered markets ("Plenish high oleic soybeans helping recapture oil markets," 2013). These costs will not be covered if growers do not participate in programs i.e. plant HOS varieties.

The methodology used to address these questions is based on a choice experiment. There were five steps taken to construct and analyze the output of the choice experiment. The first step was to decide on the program attributes and levels to include in the survey. This was done through a review of the literature, by analyzing actual HOS segregation programs and through discussion with people informed about the topic. The attributes decided upon were premium levels, delivery options, distance to buyer, HOS brand names and threshold tests. The second step was to vary attribute levels across choice sets. After the survey was finalized[2] the third step was to e-mail the choice experiment to the subjects and wait for responses of the survey participants. The fourth step was to create a database for use in an econometric model specifically coded for the study. The fifth and final step was to analyze the output to begin filling the gap in the literature about best HOS program attribute level combinations.

[2] See Chapter 3 "Methodology" for a more thorough discussion of the experimental design.

2. Literature Review

The literature review is focused on current and past research investigating participation in segregation programs and contract (program) construction problems. Particular emphasis will be given to articles approaching these problems with the use discrete choice analysis to reveal grower preferences for different contract attributes. Very few studies have been undertaken using choice analysis to analyze growers' willingness-to-accept participation in a crop segregation program. A group of programs that have received attention are known as agri-environmental schemes (AES) of the European Union. The conclusion draws from studies analyzing these programs are the most applicable with regards to the objective of this thesis.

Relevant variables associated with segregation programs can be placed into one of two categories, which are farmer and program attributes. Farmer attributes refer to demographic and farmographic variables. Past research investigates whether heterogeneities exist among growers or a farm business regarding preference for different contract attributes.

The first two sections of the literature review are devoted to studies that researched farmer factors (demographics and farmographics) and the next two sections review studies that focused more on program attributes. One of the sections related to program attributes explains how simulation has been used as a methodology to provide knowledge and the other section is devoted to choice analysis. Discrete choice analysis is the method used in this research to draw conclusions and therefore, the information presented in this section is most relevant.

A. Demographics of Grower Participants in Programs

Segregation programs where crops with biotech traits are transacted have only been around for several decades. During this timeframe scholars have identified significant demographic variables of growers choosing to participate in a segregation program. Knowing this information allows for a better understanding of which growers and markets to approach when trying to entice farmers to participate in segregation programs for biotech crops.

Network effects and age have been identified as a set of significant demographic factors leading to the adoption and diffusion of contracts by producers (James, Klein, & Sykuta, 2011). Word-of-mouth and density of growers in a region are examples of network effect variables. Espinosa-Goded et al. (2010) conducted a survey in several regions with the object of identifying significant demographic factors influencing participation in a specific type of segregation program. Their findings suggest that the environmental attitudes of growers in a region influences willingness-to-accept participation in an agri-environmental scheme (Espinosa-Goded et al., 2010).

Age is another significant demographic variable explaining participation in a program where a segregated crop is transacted. Older growers are less willing to sign a crop marketing contract (Bellemare, 2012). With each additional year in age, growers are approximately 2% less likely to participate in contract farming (Bellemare, 2012). Gender, education level and years of farming experience have also been examined but the significance of these variables differs across studies (Ruto & Garrod, 2009).

B. Farmographics of Grower Participants in Programs

Significant farmographic variables explaining participation in a segregated crop program include farm size, farm debt, social characteristics of markets, and a regions asset base. Larger farm sizes, in terms of net sales, are more likely to contract part of their production acreage (Bellemare, 2012; James, et al., 2011; MacDonald & Korb, 2008). Large farms in the United States, those with at least $1 million dollars in sales, used contracts nearly 70% of the time in 2008 (MacDonald & Korb, 2008). Total production contracted for by these large farm businesses represented about 50% total production acreage in 2008. Small farms in the United States, $250,000 or less in sales, utilized contracts in only 7% of cases and total small farm production under contract was 16% (MacDonald & Korb, 2008). One of the reason why large farms are more likely to enter contractual agreement for their production relate to the fact that contracting does not favor small farms because larger fixed transaction and compliance costs are encountered by these firms (Ducos, Dupraz, & Bonnieux, 2009; Vavra, 2009).

The amount of debt a farm business has is another significant farmographic variable impacting growers' decision to participate in segregation programs. Grain and oilseed farm businesses using contracts, on average, have more debt per net worth than farms not using contracts. Farm businesses that contracted production acreage had an average debt of about 16% of net worth in 2008 (MacDonald & Korb, 2008). Farms that did not contract maintained about a 5% debt ratio (MacDonald & Korb, 2008).

A regions asset base or institutional setting is another factor influencing growers willingness-to-participate in contract agriculture (Espinosa-Goded et al., 2010). Soil type is significant to a grower's decision to plant a crop under contract. A grower will not plant HOS if the seed will not perform well on his/her land. Also, a certain degree of asset specificity is realized for HOS transactions. HOS batches must enter into a soybean crushing facility for large volumes of oil extraction. Proximity (distance) to a crushing facility also impacts a grower's decision to participate in a segregation program. If a grower normally delivers grain to a buyer 10 miles away, but the only buyer of HOS's is 35 miles away, opportunity costs may be high. Previous literature has depicted this as an arbitrage criterion (Gloy & Dooley, 2003; Maltsbarger & Kalaitzandonakes, 2001).

C. Previous Studies Investigating Grower Response to Segregation Programs

The previous literature has also identified program attributes related to agricultural segregation programs which impact the participation in these programs by growers and others across the supply chain. Various methods have been utilized to determine the significance of these attributes. Simulation, choice analysis and case studies of segregation programs have been used to address contractual issues closely related to this thesis. Simulation has been used to evaluate best management practices for incorporating a new agbiotech crop trait, non-GMO grain or other identity preserved/segregated crop into corresponding supply chains. These studies examined how changing an attribute of a segregation program or a regional buyer's asset configuration impact costs and efficiencies (Kalaitzandonakes, Maltsbarger, & Barnes, 2001; Lentz & Akridge, 1997; Maltsbarger, 1999; Maltsbarger & Kalaitzandonakes, 2001; Wilson, et al., 2008).

The studies weigh tradeoffs and opportunity costs of different scenarios, which represent different volumes of segregated grain entering into different buyers asset configurations through various methods of delivery at differing times (Maltsbarger, 1999; Kalaitzandonakes & Maltsbarger, 2001). Crop-to-bin assignments are also changed across scenarios and this allows for conclusions to be made related to best-management practices a buyer may undertake when participating in identity preserved/segregated crop supply transaction. A main conclusion to come from these studies was that nearly all factors related to participation in a segregation program significantly impacted a buyers opportunity costs (Maltsbarger, 1999; Kalaitzandonakes & Maltsbarger, 2001).

A significant finding relevant to this thesis is that scenarios using a harvest delivery option have lower coordination costs than those using the buyers call delivery option (Maltsbarger & Kalaitzandonakes, 2001). But buyers call scenarios result in lower opportunity costs for buyers. Differences between the two delivery options are dependent on the parameters of each scenario; for example, the asset configuration of a buyer or the quantity of identity preserved high oleic corn entering into facilities (Maltsbarger, 1999). Because of this buyers must carefully weigh the decision to participate in a segregated crop system (Maltsbarger, 1999 and Kalaitzandonakes & Maltsbarger, 2001).

Previous studies have also used choice analysis to show how growers react to program attributes. However, the number of these studies is limited and none have focused on the HOS segregation program. Segregation programs (schemes) that have received attention are the agri-environmental schemes (AES) of the European Union (EU).

D. Conclusions about Agri-Environmental Scheme (AES) Attributes Using Discrete Choice Analysis

AES's were included in the European Union's (EU) Common Agricultural Policy (CAP), during the 1980s (Ducos, et al., 2009). These schemes are designed to prolong land quality (Ruto & Garrod, 2009) and participations to these programs are voluntary and vary. In some schemes a grower agrees to plant a nitrogen fixing crop and in others land is idled. Lack of participation in AES has been motivating most of these studies (Espinosa-Goded, Barreiro-Hurlé, & Ruto, 2010).

Studies approaching program adoption and construction problems begin by identifying attributes of interest. Attributes influencing participation in an AES are classified as farmer factors (demographics and farmographics) and scheme factors (attributes of AES) in previous literature (Ruto & Garrod, 2009). Farmer factors are fixed and not much can be done to cause these to change (Ruto & Garrod, 2009).

Scheme factors are not fixed and policy makers for AES may alter these as new information becomes available (Espinosa-Goded, et al., 2010; Ruto & Garrod, 2009).

Many AES studies have been conducted to uncover significant farmer factors influencing AES participation (Ducos, et al., 2009; Ruto & Garrod, 2009; Vanslembrouck, Huylenbroeck, & Verbeke, 2002). Farm sizes, age of grower, education level and interest in the environment have been found to be significant farmer factors (Ducos, et al., 2009; Ruto & Garrod, 2009; Vanslembrouck, et al., 2002). Scheme factors i.e. program attributes which growers must follow upon participation in an AES are less researched by scholars interested in understanding what influences grower participation in AES (Ruto & Garrod, 2009). Scheme factors of interest have included premiums, the length of agreement, flexibility of acreage devoted to a program, the extent of ex-ante contracting costs and other fixed and variable costs (Espinosa-Goded, et al., 2010; Ruto & Garrod, 2009). Costs are exogenous program attributes because they cannot be explicitly stated like premium levels can in AES.

There is much uncertainty amongst growers about AES's (Christensen et al., 2011; Espinosa-Goded, et al., 2010). Growers do not completely understand how participation in a scheme will influence their farm businesses profitability because costs are often misperceived (Christensen, et al., 2011; Espinosa-Goded, et al., 2010). Also, there appears to be a lack of understanding in how and when premiums for participation would be received (Christensen, et al., 2011). These are both reasons why many growers would prefer to maintain current farm practices and choose to opt-out of a scheme (Espinosa-Goded, et al., 2010).

Conclusions about program construction problems found in an AES study can be used to investigate participation in the schemes by growers (Espinosa-Goded, et al., 2010). A programs length, flexibility, time to implement, additional payments (premiums) and amount of land to be devoted are all found to be statistically significant attributes (Ruto & Garrod, 2009). Conclusions made across literatures about these attributes are similar and provide an understanding of a grower's preference for certain program attributes and combinations of attributes.

A main conclusion from AES studies about scheme factors is that higher premium payments increase a grower's willingness-to-accept participation in schemes; however, growers are willing to trade off higher premium levels for other scheme attributes (Christensen, et al., 2011; Espinosa-Goded, et al., 2010; Ruto & Garrod, 2009; Vanslembrouck, et al., 2002). Christensen et al., (2011) conclude that "the vast majority of farmers (86%) are willing to trade off scheme requirements against the size of the subsidy." This is likely because the use of certain attributes and combinations of AES attributes result in lowered costs and more savings for growers (Espinosa-Goded, et al., 2010). For example, growers are willing-to-accept participation for 24.6 €/ha less premium for schemes that do not require at least 50% enrolment of eligible acreage (Espinosa-Goded, et al., 2010). Also, growers are willing-to-accept lower premiums when compulsory technical support and monitoring are given because this reduces the time she/he must devote to the scheme (Espinosa-Goded, et al., 2010). Furthermore, growers would prefer to participate in a scheme that requires less paperwork (Espinosa-Goded, et al., 2010; Ruto & Garrod, 2009).

Growers prefer contracts that are flexible and ones with many options (Christensen, et al., 2011; Espinosa-Goded, et al., 2010; Ruto & Garrod, 2009). Flexibility and options allow growers to manage their business in a way they are used to doing - meaning less time and efforts will need to be undertaken. Farmers weight or value attributes differently and demand more flexibility in certain attributes when compared with others (Christensen, et al., 2011). Growers would prefer to have flexibility in the amount of land that must be entered into a scheme (Espinosa-Goded, et al., 2010). Furthermore, growers prefer having the option of choosing which section of their production acreage to devote to a scheme. When a scheme requires growers to plant a crop which cattle may graze, growers would prefer to have the option of letting cattle graze the land.

Certain scheme attributes are not preferred by growers, but policy makers can use combinations of attributes to entice participation. Growers do not want to lock themselves into a scheme for many years and they will choose to opt out if they are constrained to participate for a long period of time (Christensen, et al., 2011; Ruto & Garrod, 2009). However, an option growers value is the ability to opt out of a scheme prior to the ex-ante agreed upon length of an agreement (Christensen, et al., 2011). Also, growers would prefer to opt-out and not participate in a scheme when attributes prohibit a farm manager's ability to take certain actions on his/her own land (Espinosa-Goded, et al., 2010). Regardless, if policy makers feel attributes cannot be left out of a scheme higher premium levels may be used as incentive for growers to accept these terms (Espinosa-Goded, et al., 2010). The continual modification of attributes may reduce transaction costs realized by parties and conclusions from AES choice analysis studies may be used by policy makers to determine optimal attribute levels and combinations (Espinosa-Goded, et al., 2010).

E. The Gap in the Literature

The main discussion revolved around conclusions related to attributes contained in a program influencing a grower's choice of participation in a program. Very few programs have been analyzed in this way, but the EU's agri-environmental schemes have received attention. This literature review provides further evidence that relevant conclusions can be drawn with choice experiments in like literature i.e. choice analysis studies providing information about AES attributes (Christensen, et al., 2011; Espinosa-Goded, et al., 2010; Gallardo, Lusk, Holcomb, & Rayas-Duarte, 2009).

AES's are agricultural segregation programs similar, yet different when compared to the HOS segregation program. One difference is the length of these scheme agreements may be several years whereas in the HOS segregation program growers agree to participate for a growing season. Another difference is that in AES's there is a release-option i.e. growers may decide against participation in the scheme at some point during the original agreement term (Christensen, et al., 2011).

HOS segregation programs do not have this term; therefore, these conclusions cannot be taken from one program or scheme and applied directly to another.

Every new program requires novel written material to fill a gap in the literature (Lentz & Akridge, 1997). Because HOS segregation programs are new this thesis seeks to fulfill this objective using discrete choice analysis as the research methodology. To the author's knowledge, no choice experiment has analyzed grower preferences for HOS segregation program attributes most influential to a grower's choice to participate in a program. Furthermore, to the author's knowledge, no literature has compared HOS program choice experiment results with actual HOS programs to provide recommendations.

The following chapter describes the choice experiment implemented for this thesis. This allows to analyze the most responses attributes levels in terms of growers' participation in a HOS segregation program. After the methodology has been explained, results and conclusions will be discussed.

3. Methodology

Agricultural economists were pioneers in the use of choice analysis (Unnevehr et al., 2010). They were the first group of scholars to evaluate consumer willingness-to-pay (WTP) for food and agricultural related goods and the first group of academics to use choice analysis for explaining what attributes trigger a grower's willingness-to-accept participation in a crop segregation program. To produce these insights, revealed preference data from discrete choice surveys were coupled with theoretical economic models (Unnevehr, et al., 2010).

The purpose of this chapter is to describe the experimental design of the choice experiment and explain how it was used to accomplish the main objective. The chapter articulates what a choice experiment is and how they are used to make observations about the preference behavior of growers for five attributes of HOS segregation programs - premium levels, delivery options and timeframe implications, distance to buyer, HOS brand name and purity threshold tests.

A. Goods and attribute bundle

Goods are a bundle of attributes that must be purchased as one unit (Unnevehr, et al., 2010). For the purposes of this study, HOS segregation programs are considered goods. Premium levels, delivery options, distance to buyer, threshold tests and brand name of HOS are attributes comprising a program. Each attribute is individually ranked for importance by growers. When deciding upon participation in a HOS program, an individuals' choice is made by taking his/her attribute level preferences into consideration. Attribute comparisons are made across programs and a "utility or preference ordering" for a collection of attributes is created by growers (Lancaster, 1996).

An estimated mean utility is a unit of measurement for the amount of happiness or satisfaction an average good provides an individual (Hensher, Rose, & Greene, 2005). This mean utility is the sum of marginal utility estimates for individual attributes of the good. When a set of alternative goods is presented to a rational being, the choice made will yield the most utility. This behavioral framework is the theoretical conception of a choice experiment, which reveals preferences subjects have for combinations of attribute levels comprising goods (Espinosa-Goded, et al., 2010).

B. Experimental Design, Applied Choice Analysis

A choice experiment was used for this thesis because it place respondents in a hypothetical situation that closely mimic the real tradeoffs that growers would have to make when evaluating the attributes of contracts for different HOS programs. The choice experiment contained four choice questions and a follow-up or nested acreage question. Choice questions contained choice sets of three alternatives for survey subjects to choose between. Two of the three alternatives represented HOS segregation programs with five attributes of varying levels and the third alternative served as an opt-out alternative. Subjects chose just one alternative across each of the four choice sets. If an individual marked preference for a HOS contract pairing they were directed to an acreage question which asked respondents "how many acres would you devote to the HOS segregation program you selected?" Subjects had complete freedom in their marked answer. Data from the nested acreage question was used to predict an average participant's willingness-to-plant HOS varieties in number of acres.

Two alternatives, within each choice set, were reflective of actual HOS segregation programs. Data was collected from real programs as shown in Table 2. The column headings are used as classes to arrange the attribute found in HOS programs. Each row represents a collection of attribute levels comprising a program. The types of decisions a grower participant must make can be explained by analyzing the information in the Table 2. For instance, a grower in northwestern Ohio may be within a reasonable distance of several buyers. The Delphos, Ohio and Lima, Ohio buyers are separated by 15 miles of paved highway. Growers deciding to transact with either of these buyers will be presented program attribute pairings differing, most notably, in the delivery timeframe. Both delivery options are buyer's call, but the Lima, Ohio delivery timeframe is anytime in December, 2014 and the timeframe for Delphos, Ohio is February – March 2015. It is these types of attribute level differences across programs, which the experimental design mirrors.

Table 2 Data from 2014-15 HOS Segregation Program Contracts

Location	Company	Premium	Del Option	Delivery Timeframe	Months b/t Del
Montpelier, OH	Edon Farmers Coop	$0.50/bu	HD	HD	0
Delphos, OH	Bunge	$0.50/bu; $0.40/bu	BC; HD	Feb-Mar 2015	2
Bellevue, OH	Bunge	$0.50/bu; $0.40/bu	BC; HD	Feb-July 2015	3
Ottawa Lake, MI	ADM	$0.50/bu	BC	Feb-Mar 2015	2
Logansport, IN	ADM	$0.40/bu	Flex Del	Feb-Mar 2015	2
Decatur, IN	Bunge	$0.50/bu; $0.40/bu	BC; HD	Feb-July 2015	7
Salisbury, MD	Perdue Farms	$0.60/bu; $0.50/bu	BC; HD	Dec-Feb 2015	3
Sidney, OH	Cargill	$0.50/bu	BC	Dec-Feb 2015	2
Lima, OH	Cargill	$0.50/bu; $0.40/bu	BC; HD	Dec-14	1

Best practices to develop the design for the choice experiment were followed. The design of the choice experiment should maximize orthogonality and balance (Lusk & Norwood, 2005). Orthogonality is a test used to detect multicollinearity between independent variables. The risk of failing this test can be reduced by deciding if a variable is strongly correlated with another before adding both into the design. Balance relates to the idea of phrasing options in a way that would not promote a choice.

An optimal survey is comprised of just as many questions needed to "maximize the statistical performance of coefficient estimates" (Lusk, Roosen, & Fox, 2003). However, the number of levels and contractual measures that we considered for this choice experiment were too large to present a full factorial design to respondents. Accordingly, we used the Statistical Analysis System (SAS) to produce a balanced design with a reasonable number of choice sets. One of the designs that deemed satisfactory consisted of 36 choice sets and yielded a D-efficiency of 86%. These sets were randomly apportioned to 9 blocks so each respondent was successively presented with 4 choice sets with two alternatives in each, plus the option to opt out. This third option allowed for the experimental design to be consistent with demand theory (Hanley, Mourato, & Wright, 2001).

Table 3 Simplified Choice Experiment Matrix

Block I.D.	Questions in Block	HOS Contract Pairing 1	HOS Contract Pairing 2	Other Crop Options
1.	4	1, 2, 3, 4	5, 6, 7, 8	Other Seed Programs
2	4	9, 10, 11, 12	13, 14, 15, 16	Other Seed Programs
3.	4	17, 18, 19, 20	21, 22, 23, 24	Other Seed Programs
4.	4	25, 26, 27, 28	29, 30, 31, 32	Other Seed Programs
5.	4	33, 34, 35, 36	37, 38, 39, 40	Other Seed Programs
6.	4	41, 42, 43, 44	45, 46, 47, 48	Other Seed Programs
7.	4	49, 50, 51, 52	53, 54, 55, 56	Other Seed Programs
8.	4	57, 58, 59, 60	61, 62, 63, 64	Other Seed Programs
9.	4	65, 66, 67, 68	69, 70, 71, 72	Other Seed Programs

The five included program attributes in the choice experiment were premium levels, delivery options – timeframe implications, distance to buyer, purity threshold tests and HOS brand names. Each attribute had two or three levels. An explanation of why levels were chosen is given in the following.

i. Premiums

The choice experiment varied three levels of premiums across each of the HOS segregation program alternatives. This was done to obtain the necessary amount of information about premium levels to express the willingness to pay of the other attributes in dollar terms. The chosen levels were $0.25/bushel, $0.50/bushel and $0.75/bushel. Researchers wanted to use $0.50/bushel as the middle number to reflect the data found in actual HOS segregation programs. Of the nine 2014-15 programs (as shown in Table 2) found and analyzed, seven offered a $0.50/bushel level. The $0.25/bushel increment around the $0.50/bushel was done taking into consideration premium values found in previous segregation programs and trends across programs.

Furthermore, the method is in parallel with the double-bounded method of evaluating a consumers (producers) willingness-to-accept a change in an attributes level (Train, 2009). When three levels are used the method is known as a triple-bounded elicitation. Either way is able to approximate a precise WTA or WTP value by weighing the tradeoffs producers undertake in the simulated choice experiment survey. Each procedure may be used to "maximize a likelihood function" (Train, 2009). The same logic was used in the construction of the distance to buyer attribute levels.

Previous literature provides information about several trends of premium levels found in segregation programs. The first trend is that premium levels reflect the few segregation cost estimates assigned in previous literature providing validity to cost estimations (Kalaitzandonakes & Kaufman, 2010). Put differently, premiums are designed to offset additional segregation costs and by summing cost estimates found in previous literature this has occurred across time and space.

The second identified trend is that premium levels have been increasing over time. Kalaitzandonakes & Kaufman (2010) detail increasing premium levels "expressed as percentages over the observed farm price of the commodity, premiums represented roughly 5%-15% increments over the 2001-2009 period." Sykuta & Parcell (2003) analyzed nonGMO soybean contracts for the 1999 to 2002 growing seasons. The collection of contracts included 23 types of agricultural segregation programs and premium levels ranged from $0.10 per bushel to $0.30 per bushel soybean. Premium levels granted to growers who planted HOS varieties during the 2014-15 growing season ranged from $0.40 to $0.60 per bushel. These premiums are more than premiums found in Sykutas and Parcells (2003), providing validity to the conclusion that premium levels have been increasing over time (Kalaitzandonakes & Kaufman, 2010).

Higher premium levels will increase production of HOS varieties, but as the literature review explained growers are willing-to-accept program participation for lower premium values when presented with more flexibility and options amongst other contract terms in a segregation program (Christensen, et al., 2011; Espinosa-Goded, et al., 2010). This brings us to another significant HOS segregation program contract attribute the delivery option with timeframe implications.

ii. Delivery Options - Timeframe Implications

Delivery options are used to reduce uncertainty buyers have of when in-coming lots of a segregated crop will be delivered to facilities (Sykuta & Parcell, 2003). Harvest delivery (HD) provides grower flexibility with the timeframe to deliver his/her production to a buyer. This will likely occur immediately after a harvest. A buyers call (BC) delivery option forces growers to hold harvested grain in storage on their farms until a specified timeframe. The grower will then be called by the buyer to deliver the harvest. This will commonly be months after harvest (ex: Feb 1-Mar 31), but can extend up to a year (Sykuta & Parcell, 2003). Higher premium values are generally granted for longer delivery windows/timeframes (Sykuta & Parcell, 2003).

Sykuta & Parcell (2003) suggest that a grower's willingness to participate in a segregation program is reduced when stated delivery timeframes are longer. Longer BC timeframes restrict a grower's ability to strategically hedge the crops value (Sykuta & Parcell, 2003)and adds additional on-farm storage costs (Thakur & Hurburgh, 2009). Sykuta & Parcell (2003) also note that the delivery window is not as influential to a grower's preference of participation when compared to the first month of the BC timeframe. Put differently, a delivery timeframe of Feb-March is likely preferred over March-April by growers. The futures prices impact this preference; however.

In HOS segregation programs the two types of delivery options are harvest delivery (HD) and buyers call (BC). A BC delivery option is associated with a certain delivery timeframe; for instance, (Feb 1-March 31). The choice survey included three categorical attribute levels varied across alternatives. These were HD, BC (Feb 1-March 31) and BC (Feb 1-July 31). Levels were representative of actual HOS segregation programs. Researchers also wanted enough information to discuss implications of how growers view a BC timeframe starting in an identical month, but different in the windows length.

iii. Distance to Buyer

Distance to buyer is another continuous variable that were represented in the choice experiment with levels of 25 miles, 50 miles and 75 miles. These numbers are representative of a reasonable distance growers would travel to deliver an identity preserved crop to a buyer. Levels were varied across choice sets shown to soybean producers.

Distance has been shown to be another attribute influencing the decision of which buyer a grower chooses to transact with (Gloy & Dooley, 2003; Maltsbarger, 1999; Maltsbarger & Kalaitzandonakes, 2001). Assuming a constant fuel cost and a limited amount of time, growers that travel more miles to make a delivery will incur more costs than a grower travelling less miles to the elevator (Gloy & Dooley, 2003). Arbitrage opportunities depict a situation where a grower is confronted with a difficult decision of which grain elevator, of similar proximity, to deliver harvested crop. Growers consider opportunity costs and at some distance growers will deliver to another buyer (Gloy & Dooley, 2003).

Growers deliver grain to elevators within a reasonable proximity to the field they are harvesting. An assumption that has been made is that an average grower will choose to deliver grain to the nearest buying facility. However, this is not always the case because factors like loyalty and buyer basis impacts on cash price influence a grower's decision making. Grain elevators are in competition with other buyers in a grower's general area. They compete by offering favorable prices, while considering the facilities constraints and the local supply conditions (Gloy & Dooley, 2003; Maltsbarger & Kalaitzandonakes, 2001). Buyers offer the lowest possible price to attract the necessary quantity of a particular grain needed to most optimally utilize capacity (Gloy & Dooley, 2003).

iv. Purity Thresholds Tests

This attribute has two levels (test or no test) and researchers who designed the choice experiment varied these levels across HOS segregation program alternatives. The attribute was included in the survey because it has been depicted as a significant attribute in previous literature. Maintaining a segregated crop batch purity level should be a main priority of participants across a segregated supply chain.

Detecting differences between grain batches of large quantities would be a challenging task to do visually and so test kits are used to maintain purity. These tests align consumer demand for specialty crop products with production practices by growers and others across the corresponding supply chain by detecting whether a purity threshold has been met. A purity threshold is a standard, which segregated crop batches must exceed to be considered that specific identity preserved/segregated crop (Kalaitzandonakes, et al., 2001). Threshold levels vary across space and over time; for instance, batches of nonGMO soybeans may need to be 95% or 99.5% pure, depending on a buyers preferences or a nation's policy (Kalaitzandonakes, et al., 2001). For batches of oil to be considered *high oleic,* they must have an oleic acid content of greater than 73% and a linoleic acid content of less than 3% of the fatty acid composition. Lower, or more strict, purity thresholds result in higher costs because growers must perform more task programmable steps to prevent contamination causing additional labor (time) and opportunity costs as an outcome (Kalaitzandonakes & Kaufman, 2010; Sykuta & Parcell, 2003). Also, even the most careful grower faces the risk of misreading and other uncontrollable factors (Gloy & Dooley, 2003).

Although threshold tests are important to segregation programs, the crop type impacts the amount of preventive measures that must be undertaken to ensure batch purity. Soybeans are self-pollinating, meaning cross-pollination is unlikely to occur. Assuming cross-pollination does not occur; purity may only be reduced if volunteer crops, unclean equipment or uncontrollable factors and events transpire.

v. Brand Names

Branding is a dynamic tool used to signal a products credibility, quality and risks consumers undertake when purchasing a good (Ubilava, Foster, Lusk, & Nilsson, 2011). Consumers are known to make purchasing decisions because of brand names. However, across groups of products, brand names are viewed by consumers differently.

The corn and soybean agbiotech seed sector has been characterized by several trends. These trends are important when discussing the brand names found within the sector. One trend is that a few agbiotech seed firms own an increasing proportion of the market share for corn and soybeans, but the number of independent players remains many (Wilson & Dahl, 2010). The sector is classified as having many licenses across companies, which may be thought of as the practice of working and cooperating with vertical and horizontal players. Growers have many different seed options and a conclusion, using data from 2008, is that in a majority of crop reporting districts (CRD) growers purchased corn and soybean seeds from 4-7 different companies and up to 20 or more companies in large CRDs (Wilson & Dahl, 2010). This indicates that growers do not purchase soybean seeds based exclusively on brand names.

The HOS brand name attribute was another category coded to avoid the dummy variable trap. The no-brand option was the attribute level used as a baseline for interpretation. The BC (Feb:March) and BC (Feb:July) delivery options were included in the coded econometric specifications. A further analysis is given in the following section.

C. The Database

The dependent variable (LHS) for choice experiment econometric models is a grower's choice or preference of alternative. Each alternative in a choice set was coded into in a Microsoft Excel database. The chosen alternative is represented by a – 1 - and the other two non-chosen alternatives are represented by – 2 - (Allison, 1999). So, assuming each respondent completed the survey entirely she/he was associated with 12 rows of the final database. The next step was to enter in the independent variables. All attribute level combinations comprising alternatives across the four choice sets presented to subjects are the independent variables in the database.

Qualitative data is related with categorical attribute levels; such as, the threshold attribute. Upon entering qualitative data with two levels into a spreadsheet, responses should be operationalized as (0, 1). For an attribute having more than two levels (ex: HD, BC-Feb:March or BC-Feb:July), a data entry procedure must be undertaken to avoid the dummy variable trap. Program attributes, monetary in nature (premiums), or unit based (distance to buyer) were coded as continuous variables. Premium levels were entered into the spreadsheet as (0, $0.25, $0.50, or $0.75 per bushel) and distance levels were coded as (0, 25, 50, or 75 miles). This allowed for an interpretation to be stated using a specific baseline like per dollar or per mile, respectively.

The completely coded Microsoft Excel® database had 6,756 observations (rows) and 8 columns. The database was used within an econometric specification and maximum likelihood parameter estimates were outputted. These estimates were coupled with the following multinomial logit model and willingness-to-accept measurement functions to form conclusions.

D. Grower Preference and Behavior Choice Estimation Model

The theory underpinning the choice experiments is based on the random utility theory. When applied to choices made between contracts this theory assumes that growers will derive disutility from the assortment of various contract terms or specifications if these constrain them in their action or force them to incur expenses to meet the contractual terms. Assuming the utility of growers is additive, the utility which they derive from accepting a contract can then be represented with a random utility function of the type:

$$U_j = \sum_{m=1}^{M} \beta_m x_{mj} + \beta_a A_j + \varepsilon_j \qquad (1)$$

where M is the number of different contract terms in the contract, x_{mj}, is the value taken by contractual term m for a contract of type j and β_m is the (negative) utility weight, also called part-worth, associated with contract terms m (Lusk & Norwood, 2005; Hensher, et al., 2005). A_j is the payment offered to growers to accept the contract of type j so β_a corresponds to the marginal utility of income which is assumed to be constant for this specification.

ε_j is an error term which is added to the deterministic portion of the utility to represent unobserved random influences that affect the utility of each grower. The error term is assumed to be independently and identically distributed and follow a type I distribution. This utility formulation has been used with variation across choice analysis studies to form conclusions (Christensen et al., 2011;

Espinosa-Goded, Barreiro-Hurlé, & Ruto, 2010; Hensher, Rose, & Greene, 2005; Ruto & Garrod, 2009).

E. Multinomial logit model

An appropriate statistical framework needs to be used to estimate the utility parameters, β_m and β_A, in (**Error! Reference source not found.**) because each choice ecision depends on the values taken by the error terms in (**Error! Reference source not found.**) and are therefore probabilistic in nature. The probability that product j is chosen over alternative i can be expressed as:

$$P_j = \text{Prob}[\,U_j > U_i] \qquad (2)$$

Equation (1) represents a binary choice relationship between only two contract alternatives but in most choice experiments the choice set contains M alternatives. In this case the parameters of the utility function can be estimated with a variant of the multinomial logit model.

Based on the assumption made on the error term of the random utility function (1), the probabilities of choosing contract alternative j can then be expressed as a function of all the other alternatives in the choice set:

$$P_j = \frac{\exp[\,\boldsymbol{\beta}\,\mathbf{x_j}]}{\sum_{m=1}^{M} \exp[\,\boldsymbol{\beta}\,\mathbf{x_m}]} \qquad (3)$$

where $\boldsymbol{\beta}\,\mathbf{x_j} = \sum_{m=1}^{M} \beta_m x_{mj} + \beta_P P_j$ as in function (1).

This choice framework connects the grower preference model (1) with the multinomial logit model, coded into SAS, which reads in the database of observations from the researcher created choice experiment. A grower's utility cannot be directly observed, so a latent variable representing the grower's utility must be used as the dependent variable in the multinomial logit model to conform to the layout of the grower preference model (1). Simply put, by using the empirical data, utility is inferred through the choice or marked preference of each grower.

F. Monetary Willingness-to-Accept Measurement

Choice experiments have been used to produce willingness-to-accept (WTA) values and willingness-to-pay (WTP) values (Hensher, et al., 2005; Unnevehr, et al., 2010). Choice experiment studies where food consumers are subjects rather than producers have been more frequently undertaken. These studies have analyzed consumer preferences for like food products with different attribute levels e.g. branded vs. unbranded pork (Gallardo, et al., 2009; Lusk & Schroeder, 2004; Ubilava, et al., 2011). Results can be used to explain the influence attribute levels have on demand for a particular food good. A consumer's WTP for value added product quality attributes is calculated in these studies (Loureiro & Umberger, 2007; Lusk, et al., 2003; Lusk & Schroeder, 2004; Tonsor, Schroeder, & Lusk, 2013).

Previous literatures where a grower's preferences for agricultural segregation program attributes are analyzed seem to use either WTP or WTA. To do this, perspective must first be given. If a WTP value is estimated the study will detail how a change in an attribute level (ex: HD-BC delivery option) influences a growers WTP for the good (Alvarez-Farizo, 1999). Interpretation of a WTP value is that it is the monetary amount consumers would be willing-to-pay for a certain attribute.

When a WTA function is used, interpretation is the additional value growers would need to accept participation in a program because of a change in an attribute level (Espinosa-Goded, et al., 2010). This thesis makes the assumption that functions stated in previous literature estimating a WTP value can be used for estimating a WTA value.

Each, β, in function (1) represents an average grower's marginal utility or disutility received from an attribute of interest. By coupling maximum likelihood parameter estimates with function (1) a mean or expected willingness-to-accept (WTA) participation value may be found for an alternative with a particular set of attribute levels. This value will have units of utility (Ubilava, et al., 2011). By using the formula specified in equation (4), parameter estimates can be used to estimate the amount of money an individual would be willing to forego in order to be indifferent to a one unit change in an attributes level, i.e. a growers willingness-to-accept in; for example, a program having a BC (Feb-March) delivery option rather than a harvest delivery option (Gallardo, et al., 2009).

$$\text{WTA}_{attribute} = \frac{-\theta_{attribute(n)}}{\beta_{price}} \tag{4}$$

A parameter estimate in monetary units β_{price} is used in the denominator of function (4). The numerator of this function $\theta_{attribute(n)}$ is the negative of a parameter estimate that is not in monetary units. This attribute may then be interpreted in terms of price.

G. Summary

The choice experiment reflected random utility theory, which views an individual as a rational being striving to maximize his/her own utility (Hensher and el. al, 2009). The experiment "allows for multi-attribute valuation and permits the measurement of trade-offs among numerous attributes," (Lusk, et al., 2003). The revealed preference data was used to produce maximum likelihood parameter estimates. These estimates are interpreted as marginal utility weights. Estimates can be used in WTA measurement to find values with units of dollars/bushel. The acreage data of the nested survey questions was interpreted as a measurement of willingness-to-plant HOS in number of acres. The following chapter details the results of the experiment.

4. Results

Providing information resulting from the choice experiment is the focus of this chapter. The first section describes the response rate. The second section provides interpretations of revealed preference data of each choice question. Interpretation of maximum likelihood parameter estimates and monetary willingness-to-accept values allows for explanation of the program attribute level combinations most preferable to growers. Comparisons between actual HOS programs and the data collected from the choice experiment are used to make recommendations that could be used to improve the contractual arrangement between growers and buyers of HOS. The third section estimates an average grower participant's willingness-to-plant HOS varieties. Final remarks are made.

A. Response Rate of the Choice Experiment

The response rate of the survey was more than adequate to obtain statistically relevant results. All 915 of the surveys subjects were growers. 299 of the subjects did not complete any survey question, so 616 (67%) subjects completed part of the survey. However, 53 (6%) of these people did not complete the choice experiment entirely or correctly. For instance, some individuals decided to complete the choice questions only.

There were 297 (48%) respondents to the choice questions that had mixed preferences across choice sets with two participation alternatives and one non-participation alternative. This indicates that different attribute level combinations comprising HOS segregation programs are significant to a grower's choice of participation and that certain attribute pairings are preferred over others. The remaining 319 (52%) respondents preferred complete participation or non-participation across the four choice questions. 204 (33%) respondents marked complete non-participation and 115 (18.6%) respondents preferred a participation alternative across all four choice questions. This is indicative of the fact that many growers show strong preference for maintaining current farm management practices (Espinosa-Goded et. al, 2011).

B. Choice questions

Table (4) was part of the model output and it shows the overall model had a high degree of statistical significance. This is further evidence that HOS segregation programs have influence upon an average grower's willingness-to-accept participation in a program.

Table 4 Overall Model Significance

Test	Pr>ChiSq
Likelihood Ratio	<.0001
Score	<.0001
Wald	<.0001

Table (5) contains the maximum likelihood parameter estimates. Parameters estimated were transformed into WTA values in monetary units. A description of each attribute is given below the matrix. Not all attributes are shown to be statistically significant, as both brand name parameter estimates (Plenish® and

Vistive Gold®) and the threshold estimate do not pass significance tests. These attributes have very little or no influence over an average grower's willingness-to-accept (WTA) participation in a program. However, the three other estimates are highly significant at all commonly checked significance levels (.1, .05, and .01). These significant attributes are premiums, the delivery option and distance-to-buyer.

Unless more buyers accept participation in a HOS segregation program an agricultural field's proximity to a participating buyer of HOS's will not change. To provide relevant information the discussion will continue by emphasizing the main effects of premium levels and delivery options. Also, WTA estimates with units of dollars per bushel allow for explanation of how delivery option levels influence premium levels.

Table 5 Analysis of Maximum Likelihood Estimates

Attribute	Parameter Estimate	WTA estimate (units=$/bushel)	Pr>ChiSq
1. PREMIUM	3.47790		<.0001***
2. DELIVERY OPTIONS			
A. BC (Feb:March)	-0.39066	0.112	<.0001***
B. BC (Feb:July)	-0.45942	0.132	<.0001***
3. DISTANCE	-0.00899	0.003	<.0001***
4. HOS BRAND NAMES			
A. Plenish®	.04064	-0.011	.6535
B. Vistive Gold®	-.12254	0.035	.1820
5. Threshold	-.02123	0.006	.7652
INT	2.20286		<.0001***

Description of the program (contract) attributes and description and interpretation of INT.:

1. Premium: Continue variable where units=dollars. ***Significant at all checked levels.
2. BC (Feb:March): Buyers Call delivery option with 2 month timeframe. This variable was created to avoid the dummy variable trap. ***Significant at all checked levels.
3. BC (Feb:July): Buyers Call delivery option with 6 month timeframe. This variable was created to avoid the dummy variable trap. ***Significant at all checked levels.
4. DISTANCE: Continuous variable where units=miles. ***Significant at all checked levels.
5. Plenish®: Brand name line-up of Pioneer-Dupont HOS varieties. This variable was created to avoid the dummy variable trap. Non-branded HOS was attribute level excluded from model. Not significant.
6. Vistive Gold®: Brand name line-up of Monsanto Company's HOS varieties. This variable was created to avoid the dummy variable trap. Non-branded HOS was attribute level excluded from model. Not significant.
7. Threshold: Binary (dummy) variable where (1) = test. Not significant.
8. INT: Binary coded where (1) = non-participation alternative. Interpretation of this attribute is that it is the utility an average grower receives from opting out. ***Significant at all checked levels.

i. Interpretation of Results from the choice experiment: An Ordered System.

Because this research used choice experiment data the parameter estimates are interpreted using marginal utility to explain a change in choice (the dependent variable) rather than log-odds. Also, "the overall scale of utility is irrelevant" (Train, 2009). For this reason, results of the choice experiment are used to weight preferences of contract attributes comprising HOS segregation programs. Put differently, certain program attributes are more valued by an average grower and the parameter estimates can be used to identify which are of more importance to growers.

1. Premium

A grower participants' overall utility is positively impacted by larger premium levels. Results show that premiums are significant and influence a grower's willingness-to-accept participation in a HOS segregation program. The premium attribute is interpreted as marginal utility of income against which all the other parameters can be compared against. Compared to all other HOS segregation program attributes of interest premium levels may most effectively be used to influence production of HOS's. One conclusion is that growers seem to be willing-to-accept participation in a program with lower premium levels when certain other program attributes are presented in contracts. In particular, the growers would prefer to have a high amount of flexibility in the delivery option and timeframe.

2. *Delivery Options - Timeframe Implications.*

Growers are sensitive to changes in the type of delivery option used in a program. The delivery option - timeframe attribute has statistical significance at all commonly checked confidence levels. In the choice experiment sent to growers, three attribute levels were varied across choice sets. Because of this the harvest delivery (HD) option was excluded from the database to avoid the dummy variable trap. This attribute level is used as a baseline for interpretation.

The BC (Feb:March) estimate means a grower's utility will be 0.39066 less if this BC option rather than when a HD option is used. The monetary WTA estimate of 0.112 can be interpreted as growers are willing-to-accept is $0.112 less of a premium per bushel if given the HD option instead of a BC (Feb:March) delivery option. Furthermore, the BC (Feb:July) estimate means the overall utility a grower receives from participation would be 0.45942 less when this option is stated in a contract rather than the HD option. The WTA estimate concludes that growers are willing-to-accept $0.132 less of a premium when given the HD option rather than the BC (Feb:July) delivery option.

By comparing the monetary WTA estimates for the two BC delivery options conclusions can be made about preferences of delivery windows and timeframes. Consider that Feb-March is a two month delivery window and Feb-July is a seven month delivery window, the difference being about five months. The difference between the BC (Feb:March) and BC (Feb:July) attribute estimates is $0.02/bushel. This shows that for each additional month of the five months, growers require less than $0.005 more to be willing to accept participation in the program. This further proves that growers would prefer to have the opportunity to make delivery in a timeframe close to or immediately after harvest, assuming a fixed premium level. Further research is needed to understand a grower's preference for a BC delivery option with a timeframe window of; for example, (Dec-Feb) versus one with a (Feb:July) timeframe. Cash prices fluctuate across time and space but some month blocks of the futures market are historically better for growers to sell in than others and informed grower members have this knowledge.

The main takeaway is that the *harvest delivery* option is an average grower's most preferred delivery option. Growers are more willing-to-accept participation in a HOS program with this delivery option rather than a BC option. However, if decision makers decide a BC delivery option must be included in a program higher premium levels may be used as incentive for growers to be more willing-to-accept this trade-off.

3. Distance

Distance to buyer is the only other significant HOS segregation program attribute. The attribute is a continuous variable with units of miles. Interpretation is that for each additional mile to buyer the utility level realized by a grower will decrease by 0.00899. The monetary WTA estimate predicts the growers require $0.003 per bushel for each additional mile travelled to be willing-to-transact HOS varieties with a participating buyer. In a scenario where a participating grower would deliver harvested HOS batches to a buyer he normally transacts with opportunity costs are low. When this is not true, opportunity costs are high, in the growers mind, or about $3.00 for each additional mile a HOS load travels.

Although this is small value per bushel, a conclusion that can be made is that at a certain distance to buyer, growers will not be willing-to-accept participation in a program if their typical buyer from field X is not participating (Gloy & Dooley, 2003). A grower's overall utility and net income per bushel are reduced when she or he must undertake additional time and distance to deliver a harvested HOS crop. Arbitrage situations are considered by growers. Also, there is a limited number of participating buyers and many of these buyers are located in Ohio. About thirty of the fifty United States produced soybeans in 2014-15, but less than five had HOS varieties planted. Distance to participating buyer is an attribute that significantly influences the production of HOS varieties.

4. Brand Name

The non-significance of both brand name attributes is evidence that growers are increasingly not influenced to plant a seed because of its brand name. Findings suggest that the overall utility of an average grower's decision to market his/her grain is not significantly influenced because of the brand name HOS planted. The purpose of this research is not to investigate potential reasons to explain this finding, but several are given.

One explanation may be that the seed industry has realized a lot of change over the past several decades. Many large firms have vertically integrated or contracted with other firms making it difficult to know for certain that a brand is what it used to be and not altered in some way (Wilson & Dahl, 2010). The industry is characterized by licensing agreements across companies and traits found within one seed brand may actually be owned by other companies and, often times, these traits are branded. Secondly, seed salesmen are in competition with one another and growers routinely purchase from many of these actors.

5. Threshold

The threshold attribute is a binary variable that represents the possibility of a purity threshold test. This attribute estimate is found to be not significant in a grower's choice of participation in a HOS segregation program. Soybeans are self-pollinating plants, so the odds of cross pollination are low. Basically the only way comingling may occur is through contamination because of unclean equipment or storage facilities, volunteer crops, misreading tests or purchased bags of seed that were not originally pure. The average grower participant is likely to understand this and take precautionary measures to prevent these events from occurring. Grower participants associate a low amount of risk to failure of a HOS threshold test. Another likely explanation is that very few threshold tests are applied by an intermediary buyer on batches of grain delivered from a grower. Further research is needed in this arena.

ii. Comparing Choice Survey Results with Actual Programs

Results indicate that the premium, the delivery option (timeframe) and distance to buyer were significant program attributes influencing a grower's willingness-to-accept participation in a HOS program. As indicated by Table 6 the premium levels included in 2014-15 HOS segregation programs were $0.40, $0.50 or $0.60/bushel. These levels are dependent on the delivery option (timeframe) a grower chooses. The actual programs are flexible and provide the grower with options, but three recommendations are given as ways to improve the efficiency of the program and corresponding transaction. These recommendations are made based on the findings of the research.

One recommendation would be to critically assess current premium levels based on HOS production levels and either maintain premium levels or make adjustments. Buyers need to consider their own situation and make decisions based on metrics which identify the proportion of regular customers to their facility that participated in the program. If an acceptable level of growers (located around participating buyers) participated in the program then the main problem may not be grower participation, but buyer participation. The significant distance to buyer attribute is evidence that buyer participation is a problem because a field's proximity to participating buyer is fixed and growers would prefer additional compensation of about $3.00 per bushel for additional mileage where typical buyer is the baseline. Program designers may want to change the average premium levels granted by a buyer from a current mode level of $0.40-$0.50/bushel. Thus, more buyers would be willing-to-accept participation in programs and the influence of the significant distance constraint on HOS adoption would be reduced.

Table 6 Data from 2014-15 HOS Segregation Program Contracts (2)

Location	Company	Premium	Del Option	Delivery Timeframe	Mths b/t Del
Montpelier, Oh	Edon Farmers Coop	$.5/bu	HD	HD	0
Delphos, Oh	Bunge	$.5/bu; $.4/bu	BC; HD	Feb-Mar 2015	2
Bellevue, Oh	Bunge	$.5/bu; $.4/bu	BC; HD	Feb-July 2015	7
Ottawa Lake, MI	ADM	$.5/bu	BC	Feb-Mar 2015	2
Logansport, IN	ADM	$.4/bu	Flex Del	Feb-Mar 2015	2
Decatur, IN	Bunge	$.5/bu; $.4/bu	BC; HD	Feb-July 2015	7
Salisbury, MD	Perdue Farms	$.6/bu; $.5/bu	BC; HD	Dec-Feb 2015	3
Sidney, OH	Cargill	$.5/bu	BC	Dec-Feb 2015	2
Lima, OH	Cargill	$.5/bu; $.4/bu	BC; HD	Dec-14	1

A second recommendation is to experiment with a $0.15 per bushel premium for choosing a certain BC (timeframe) over HD. The study finds that growers are WTA participation for $-0.112/bushel or $-0.132/bushel when a BC (Feb:Mar) or BC (Feb:July), are used, respectively, rather than a HD option. In five of the nine collected 2014-15 HOS programs growers were given the option of either HD or BC (timeframe). If growers were to choose a BC delivery option then they must be willing-to-accept $0.10 per bushel less than when choosing a HD option.

Current program designs allowing growers to choose between several delivery options is a great way to promote adoption; however, it appears that contract designers prefer to state premium levels that are multiples of ten. The reasoning is likely very logical i.e. fewer accounting errors, but one suggestion would be to experiment with values that are multiples of five like $0.15 per bushel premium. A larger difference between BC (timeframe) and HD would allow buyers a greater ability to move other crops in and out of facilities before integrating HOS batches as more growers would be willing-to-accept participation in a program which includes a buyer's call delivery option.

A third recommendation is for participating buyers to start planning to incorporate HOS varieties early and make periodical evaluations for a most efficient outcome. If both delivery options are available to growers then it can be expected that batches of HOS's will enter into facilities shortly after harvest and during the BC timeframe. This means those bins will need to be assigned as HOS over that entire duration to prevent co-mingling. Buyers should critically assess price levels and delivery options as the opportunity cost of underutilized storage capacity is high (Maltsbarger, 1999; Kalaitzandonakes & Maltsbarger, 2001). The timeframe of stated delivery option coupled with the futures market pricing periods is very important to this discussion. Premium levels have been fixed in programs but the stated monthly or two-monthly periods of future prices fluctuate historically and trends have been shown to occur. Further research is needed to acquire more understanding of this aspect of the program construction problem. Contingencies could be stated based on the final call agreement in a BC (timeframe) option, for instance.

iii. Main Findings of the Choice Experiment

The study's findings are useful for HOS segregation program developers, agricultural supply agreement negotiators (crop marketing consultant or crop broker), academics, the growers and the buyers. The findings are grouped into one of two main types of conclusions. One type of conclusion discusses the main effects of premiums, delivery options and distance-to-buyer. The second type of conclusion details the interaction between premium levels and the delivery options, using WTA estimates. The conclusions can be applied to the program construction and adoptions problems (questions) which guided the discussion. Transaction costs would be lowered and higher adoption of HOS varieties would be realized if the main findings are implemented by stakeholders.

The main effect of each significant attribute will be ranked or weighed by individual growers differently. But, the results of the study show that an average grower will be most influenced by the premium level, the delivery option and distance-to-buyer respectively. Higher premiums will result in more grower participation in a HOS program. When compared with a BC delivery option, the HD option will provide a grower with more utility. A longer distance-to-buyer will reduce a grower's overall utility received from participation in a program. The significant distance-to-buyer attribute indicates that both grower and buyer participation is needed. A greater amount of strategically located capacity dedicated to receiving batches of HOS would reduce the attributes influence. Results from previous studies focused on buyer participation in programs should be used in parallel with conclusions made in this research and more research, from both perspectives, would be useful.

The interaction between premium levels and delivery options was addressed. Growers are willing-to-accept about $0.12 per bushel less of a premium level when a HD option rather than either a BC (Feb:Mar) or BC (Feb:July) option is included in a program. Although a similar difference is already found within HOS programs, a recommendation is for program designers to experiment with a larger than $0.12 per bushel premium. This would give incentive for growers to accept participation in a program with a BC option. The BC option is valued by buyers because it allows more flexibility in elevator management practices. Regardless, both the growers and the buyers should critically access the delivery options and premium levels and choose the option best for their situation.

C. Acreage questions

Data received were used to estimate or predict the number of HOS acres an average grower participant would be willing-to-plant with HOS varieties. Many respondents marked different acreage levels across the four questions causing some complexity in the best way to predict an average grower participant's willingness-to-plant HOS's in number of acres. Multiple ways were used to make this prediction, but the following was found to be the best representation of the data.

A two-step procedure was used to predict that an average grower participant would be willing-to-plant on average (197.55) acres of HOS's. The first step of the procedure was a formula which found the average number of acres a grower participant would be willing-to-plant with HOS varieties. If a grower respondent marked (200) acres for (1/4) of the acreage questions that he was presented, (100) acres for another nested acreage question and (0) acres for the remaining two acreage questions, the formula would depict this grower as being willing-to-plant

(150) acres of HOS's. (197.55) is the average across all the respondents using this technique.

This value and certain intervals around it may be used to estimate other values like the number of growers needed to achieve the United Soybean Board's checkoff goal of 18 million planted acres of HOS by 2023. To achieve this goal about 91,117 growers would need to participate in the program. The information provided in this document is designed to be a knowledge source to make this happen.

D. Final Remarks

The HOS segregation program contains attributes which facilitate the supply of pure HOS batches from a grower's field to a soybean processing (crushing) facility. These attributes allocate value, decision rights and property rights (Sykuta & Parcell, 2003). Attributes are of various levels and the purpose of this project was to provide information about grower preferences for certain HOS program attribute level pairings. By providing knowledge about how best to construct a program, higher adoption levels of HOS's may be more easily attained. This research was a first to approach these problems.

The choice experiment simulated the decision making process undertaken by a soybean farmer in a HOS segregation program. Results show that the premium level, the delivery option and the distance to buyer are significant to a grower's willingness-to-accept participation in a HOS segregation program. The growers consider premium levels as the most important attribute comprising a program and growers are willing-to-accept participation in a program for about $0.12/bushel less if a harvest delivery option rather than a buyer's call deliver option is given. The significance of the distance-to-buyer attribute indicates that more research is needed to analyze the best management techniques a buyer should undertake when incorporating a batch of HOS's.

Final recommendations have been given to stakeholders. The current programs have many options available to growers and current premium levels should more than exceed additional segregation costs incurred due to participation. Growers should be willing-to-plant HOS for lower premium levels so that more buyers would be willing-to-accept participation in a program. Higher production levels of HOS's would be achieved as growers would be able to transact with their typical HOS buyer.

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