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**The Cotton Wizard: A Software
Implementation of a Cotton Variety
Selection Model**

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**THE COTTON WIZARD: A SOFTWARE
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by

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ABSTRACT

The Cotton Wizard is an implementation of a cotton variety selection model intended to assist decision-makers (including producers, farm managers, extension specialists, and breeders) in variety selection. The program uses objective cotton performance test data available from state agricultural experiment stations. The decision criteria for variety selection are based on expected economic return (mean net revenue) of a variety and the variability of returns (coefficient of variation). Total revenue is calculated from lint price and seed price, and lint and seed yields. Lint and seed prices are determined by their respective quality characteristics. Adjustments are made for costs that may differ among varieties, such as planting seed cost (seed and technology costs), harvest and ginning costs, and herbicide and insecticide costs in comparisons of transgenic and conventional varieties. Users are provided with information on varieties—such as mean net revenue (total revenue less costs), variability in net revenue, and agronomic characteristics—to aid in the decision process. The Cotton Wizard is available as a Web application.

The Cotton Wizard: A Software Implementation of a

Cotton Variety Selection Model

Variety selection is a significant determinant of profitability of a farm and is one of the fundamental decision-making processes faced by producers, farm managers, extension specialists, seed companies, and breeders. When selecting a cotton (*Gossypum hirsutum, L*) variety, the decision-maker must determine the most profitable variety for a given set of environmental conditions (e.g., weather, soil structure and composition, pest, weed, and disease occurrence, and market conditions). Cotton variety selection is somewhat more difficult than in other crops because two products, lint and seed, are produced, and each product is priced according to a number of quality attributes (fiber strength, length, micronaire, color grade, etc., for lint; and oil percent, ammonia percent, etc., for seed). When selecting cotton varieties, decision-makers consider the expected performance of varieties (i.e., expected lint and seed yields) for the set of environmental conditions predominant at their location and the numerous quality attributes of lint and seed for each variety that affect their respective prices.

Analyzing and interpreting data for variety selection can be performed using various methods. One approach consists of selecting varieties from a catalog (Metzer and Supack, 1993; Townsend et al., 1994). This approach provides the decision-maker with varietal performance and agronomic characteristics of each variety. However, data analysis from catalogs can be a cumbersome process given that a large number of performance and agronomic traits are usually included. Thus, a catalog search can yield poor results. Segarra and Gannaway (1994) provide another approach to variety selection by using stochastic dominance to rank cotton varieties and select the most profitable ones. Variables used in this selection procedure include mean profit derived from lint (as a function of its yield and quality attributes) and variability. Gellner (1989)

proposed another approach to variety selection when he used historical yield data (3-year averages selected from a 16-year period) to predict superior yielding spring wheat and oat cultivars. His selection criteria were based solely on mean yields and did not include variability. The results obtained by Gellner demonstrate that the best predictions are made when using the last three years of data.

Kang (1993) proposed that both mean yields and variability should be considered when selecting varieties, even when short-term data are employed. Kang found that variety selection based on these parameters has positive economic effects for producers when applied on a regular (continuous) basis. International research centers such as CIMMYT (Centro Internacional de Mejoramiento de Maiz y Trigo) include mean yield and variability in the selection of new cultivars. The variety selection program developed at CIMMYT is noteworthy in that the selected cultivars must have the highest yields and the lowest variability across environments (Austin and Arnold, 1989).

The approaches previously described use objective data generated from experimental trials. Other approaches use data generated by decision-makers' perceptions about yields and quality (i.e., subjective data). Wiley (1994) developed a method to assess economic performance of cotton genotypes using subjective yield and fiber quality data.

Variety selection for most crops is based on mean return and variability of a single output. By comparison, a cotton crop produces two outputs, lint and seed. Most research breeding programs and economic analysis of cotton are concerned with lint because it accounts for about 87% of the crop's revenue (Kinard, 1993). Cottonseed research is mainly focused on planting seed characteristics, not with its performance as an output of cotton production. However, while cotton lint produces a large share of cotton revenue, cottonseed still accounts for a significant

portion of the crop's total revenue (10-20%). Therefore, consideration of the seed component is appropriate when modeling cotton total revenue and making variety selection decisions.

Variety selection is greatly enhanced by the integration of selection procedures into a computer software application, allowing fast and efficient analysis of large quantities of data by a wide range of individuals. Such computer applications range from expert systems models to crop growth models to simulation models that characterize the dynamics of specific pests and diseases (McGregor and Thornton, 1990; Porter, 1995; Peterson, et al., 2004). Relational database models are used to store historical crop performance test data for use in variety selection (e.g., Deltasoy by Zhang, et al. (2002); International Consortium for Agricultural Systems Applications Data Exchange by Bostick, et al. (2004); and DUDE by Yan and Tinker (2007)). Some of these models assist producers in selecting varieties, but few of them include cotton as part of their crop list. Lauer (1995) provides a review of microcomputer applications used in crop variety selection.

There are three specific computer applications for selecting cotton varieties: (1) Texas Cotton Variety Selection Model—TECOVA (Wiley, 1994); (2) GINNet (Chewning, Zeplin, and Vodicka, 1995); and (3) COTVAR (Bourland and Jones, 2007). TECOVA measures varietal performance based on mean revenue and variability, which are estimated using subjective probability distributions of lint yield and quality characteristics. GINNet measures varietal performance using objective probability distributions generated from individual producer data. Although it can be used for variety selection, the main objective of GINNet is to help ginners and producers to "improve cotton profits through rigorous analysis of USDA HVI data." COTVAR was developed to summarize cotton variety performance test data for five states in the Mississippi Delta region. The program allows multiple comparisons of selected cotton varietal

characteristics across a number of test locations. All of these models are focused on the impact of lint yield and quality on total revenue and ignore the seed component as part of a producer's income.

Specific Problem and Objectives

Selecting a cotton variety to plant is a complicated decision faced by cotton producers. To select appropriate varieties, a large amount of information must be analyzed to derive estimates of economic and agronomic performance for each variety under consideration. Such factors as lint quantity and quality, seed yield, seed quality, gin turnout, expected revenue and variability of revenue (risk) must be considered before an informed decision can be made. However, the amount of data to be analyzed often precludes decision-makers considering all information. As such, an objective and efficient method of analyzing cotton data is needed.

Quantitative (mathematical) decision models provide an objective method of comparing cotton varieties. However, such models do not solve the logistical problem inherent in analysis of large amounts of data involving complex relationships. Thus, a cotton variety selection model developed by Olaciregui (1996) has been implemented as a computer software application called the "Cotton Wizard." The application automates the implementation of the decision model, thus solving both the logistical and objectivity problems.

APPLICATION DESCRIPTION

The Cotton Wizard software application is designed to assist decision-makers with the selection of cotton varieties. The main features of the application are:

1. Use of cotton performance data generated by agricultural experiment stations;

2. Inclusion of seed and lint as part of a cotton crop's total revenue;

3. Simultaneous use of mean return and variability in variety selection.

The decision rule for variety selection combines expected economic return (mean net revenue) of a variety, the variability of returns (coefficient of variation), and the decision-maker's risk aversion level. Other economic and agronomic information on lint and seed components can be included as extra decision criteria for variety selection. Varietal performance is calculated using cotton performance test data available from agricultural experiment stations and seed quality data available from the National Cotton Variety Testing Program (USDA, ARS).

Overview

The Cotton Wizard computer software application is based on the cotton variety selection model developed by Olaciregui (1996). The model uses two measures to assess the economic performance of cotton varieties—mean net revenue (MNR) and the coefficient of variation (CV). The components of net revenue (used in calculating MNR and CV) include lint and seed yield and their respective prices adjusted for quality characteristics, and specified costs (i.e., costs that vary among varieties and are therefore important in varietial comparisons):

$NR = (PL*LY + PS*SY) - TC$

where:

NR = net revenue;

PL = lint price;

LY = lint yield;

PS = seed price;

SY = seed yield;

TC = total of specified costs.

Figure 1 provides an overview of the cotton variety selection model. The variety selection process can be divided into three steps. The first step is calculation of net revenue from total revenue and specified costs for each variety being considered. Total revenue for a variety is derived from the historical yields of lint and seed produced by a variety and the prices of lint and seed. Lint and seed prices are determined by their respective quality characteristics. Specified costs are subtracted from total revenue to determine net revenue for a variety. Specified costs should include costs that differ across varieties (i.e., seed cost; harvest and ginning costs; and herbicide and insecticide costs in comparisons of transgenic and conventional varieties). Other costs can also be included at the discretion of the user.

The second step in the variety selection process involves calculation of economic performance measures of a cotton variety. Two economic performance measures—MNR and CV—are calculated from the net revenues for a given number of years. MNR is calculated by taking the mean of a variety's yearly net revenues for a specified period. MNR provides a measure of future expected net revenue for the variety. CV is calculated by dividing the standard deviation (SD) of net revenue by MNR (i.e., CV=SD/MNR). CV provides a measure of the risk associated with planting a particular variety (this is related to yield stability in cultivar selection (May, 2000)). If CV for a variety is high, one can expect the yearly variation in net revenue for the variety to be high. As such, planting a variety with a high CV involves more risk

than planting a variety with a low CV because returns are more likely to be substantially below (or above) the expected (historical average) MNR. It is important to note that although these economic measures are based on the past performance of a variety, they provide an indication of expected future economic performance.

The third step in variety selection is the selection of a cotton variety to plant. Variety selection is made by considering MNR, CV, and the decision-maker's risk aversion level (Musser and Patrick, 2002). The risk aversion level quantifies the decision-maker's willingness to take on extra risk (higher CV) in exchange for higher potential return (higher MNR). For a given set of varieties, different decision-makers with different risk aversion levels may select different varieties. For example, a decision-maker who exhibits low risk aversion will select varieties with high MNR, and will give little consideration to CV. By comparison, a decision-maker with high risk aversion will tend to select varieties with low CV's, giving somewhat less weight to the MNR of varieties than would the former decision-maker.

Specific Features

Data—The dataset provided with the Cotton Wizard application includes cotton performance test data from variety trials reported by the Texas AgriLife Research and Extension Center (Dever, et al., 2009). The dataset currently contains data for 2000 to 2008 for five locations (Lubbock, Halfway, Lamesa, Tulia, and Pecos) and three experimental test types (Official Variety Trials, Roundup Ready Flex, and Late Planted). Replication data (four replications are typically utilized) are available for all years except 2007 (only average-of-reps data are available for 2007 due to problems with the experiments in that year). Data for seed quality characteristics are from the National Cotton Variety Testing Program (USDA, ARS). The dataset includes 13,585 records and 29 variables that measure varietal performance including: lint yield and

turnout; lint characteristics such as micronaire, fiber strength, etc.; seed yield, seed characteristics such as oil and nitrogen percent, and seed grade; and lint premium-discount (PD) and loan value based on the CCC Loan Schedule (USDA, FSA). The data are available to download into a Microsoft Excel spreadsheet.

Lint Pricing Method—The price of cotton lint for a variety is affected by its quality characteristics, including color grade, leaf grade, staple length, micronaire, fiber strength, length uniformity, and bark and other foreign matter content. Thus, price differences among varieties come from their different quality characteristics. Two sources are available that provide values (premiums and discounts) for different quality characteristics affecting lint price: (1) Daily Spot Cotton Quotations (DSCQ) from USDA, AMS; and (2) Commodity Credit Corporation (CCC) Loan Schedule from USDA, FSA. The CCC Loan Schedule is a moving average of DSCQ data, which are USDA's quoted premiums and discounts for fiber characteristics. The premiums and discounts from the CCC Loan Schedule and DSCQ are essentially the same. The Cotton Wizard uses the CCC Loan Schedule because it is easier to obtain.

Using the premiums and discounts for quality characteristics and a database containing quality characteristics of each variety, the Cotton Wizard application calculates the total premium or discount for each variety. An approximate market price for lint for each variety is calculated by adding the premium or discount for a variety to the base price of lint, which is supplied by the user based on the particular year and market conditions.

Seed Component—Agronomic and economic research programs are concerned with cotton lint because lint accounts for a major portion of cotton revenue. By contrast, research on cottonseed is mainly focused on its use as an input to cotton production (as planting seed) rather than its value as an output. However, renewed interest in seed quality and quantity issues has developed,

providing an outlet for the Cotton Wizard's ability to analyze seed quality (and quantity) across varieties (National Cotton Council, 1994).

Database Functionality—White and van Evert (2008) explain the significance of archiving agricultural experiment data for later use to check published results or to combine with data from other experiments for new analyses, potentially using new techniques developed after the initial research was published. The authors argue that "…formal methods for publishing datasets from agricultural research should be established, analogous to publishing research findings. …Mechanisms for distributing datasets also merit attention." In this regard, the database component of the Cotton Wizard application was designed to archive large cotton experiment datasets and to make these datasets accessible to researchers and decision-makers. The Cotton Wizard database is flexible to allow storage of other types of experiment data from research trials or whole-farm experiments.

Using MNR and CV in Variety Selection

MNR and CV are based on past performance of a cotton variety; however, in variety selection these measures provide an indication of how a variety might perform in the next year (i.e., expected future economic performance). When deciding which variety to plant, the decision-maker should consider both MNR and CV of a variety, and the amount of risk he/she is willing to assume for a given level of potential return. The choice depends on the individual decision-maker's willingness to take on extra risk (higher CV) in exchange for higher potential return (high MNR). For example, consider the following hypothetical situations involving two varieties: variety A has MNR=$450 (per year) and CV(%)=18; data for variety B are shown below. The decision to plant variety A or B is based on a comparison of MNR and CV for

varieties A and B and on the decision-maker's preferences for risk. The process of choosing a variety (for three situations) is explained in the right-hand column of the table.

Examples of variety selection using MRN (per acre) and CV (%).			
Situation	MNR (B)	CV (B)	Choice
Situation 1	$500	15	The best choice is variety B because it has a higher expected return (high MNR) and lower risk (low CV).
Situation 2	$425	12	The choice depends on the decision-maker's preferences. Variety B has a lower expected return (low MNR), but there is less risk associated with planting it (low CV).
Situation 3	$600	25	As in Situation 2, the choice depends on the decision-maker's preferences. Variety B has a substantially higher expected return (high MNR) but also has greater risk associated with that return (high CV).

In variety selection, the choice depends on each individual decision-maker's risk aversion level. With the performance measures (MNR and CV) provided by the Cotton Wizard application, it is possible for a decision-maker to determine which cotton variety/varieties is/are appropriate for a particular situation. The Cotton Wizard application provides the information necessary for a decision-maker to choose a variety but does not actually pick varieties.

APPLICATION OPERATION

Users of the Cotton Wizard computer software application are provided with an intuitive interface for application operation. The interface consists of a Data Selection pane and five sheets. The Data Selection pane is where the user chooses the data for analysis—the user chooses the type of data, enters the years for analysis, selects the location, and selects the varieties to be compared and the variables for analysis. The five sheets of the Cotton Wizard are explained below.

1. Dataset—This sheet shows the selected dataset of varietal information in a spreadsheet format, with the variable names shown as column headings. The selected data can be viewed and

downloaded to a spreadsheet, or used in a head-to-head comparison (sheet 3) or stability analysis (sheet 5).

2. Prices and Costs—The user enters base prices of lint and seed and the following costs: harvest and ginning, planting seed, other.

3. Head-to-Head Results—This sheet displays a table of head-to-head results of varietal performance. The table can be copied into other programs or printed on a printer.

4. Graph— On this sheet, the user chooses which variables to graph (any of the variables listed in the head-to-head results table on sheet 3 can be graphed). The Graph sheet displays a color graph of the information selected for graphing. Graphs can be printed, copied into other applications, or saved for later use.

5. Stability Analysis—On this sheet, the user chooses a single variable for stability analysis (e.g., lint revenue). A stability graph is displayed and the graph can be printed, copied into other applications, or saved for later use.

Examples of Use

Head-to-Head Comparison—The following is an example of the results generated from a sample run of the Cotton Wizard application for a head-to-head comparison. In this example, the user is a producer located in Lubbock, TX, growing cotton under irrigated conditions. The user selects the dataset for analysis (using the Data Selection pane) and enters data as follows on sheets 2-4.

Data Selection Pane and Sheet 1, Dataset—The experimental test type selected is OVT (Official Variety Trials) and the technologies selected are conventional (Conv) and Roundup Ready (R) (see the left pane of Fig. 2). Irrigated data are selected and the time period for analysis is 2005 to 2008. The state selected is Texas and the location is

Lubbock. The user selects varieties All-Tex Atlas RR, FiberMax 958, and NexGen 2448RR. The variables selected for analysis include: lint yield, lint turnout, seed turnout, micronaire, fiber length, fiber strength, uniformity, color grade, seed yield, seed grade, oil%, nitrogen%, gossypol, and loan PD. For a head-to-head comparison, the user is required to select the five variables, lint yield, lint turnout, seed yield, seed grade, and loan PD (these variables are required to calculate revenue and cost). The user clicks the check box for "Avg of Reps" to create average data from the replications of the performance test (four reps are usually available for each variety for each year). Average-of-the-reps data are required for a head-to-head comparison. The user clicks the Query button to create the dataset for analysis, which is shown on the Dataset sheet (right pane of Fig. 2). Once all information is viewed as appropriate for the analysis, the user clicks the "Prices and Costs" tab to move to sheet 2.

Sheet 2, Prices and Costs—The user enters 65¢/lb. as the base price for lint and $180/ton as the base price for seed (Fig. 3). Harvest cost is entered as $1.75/cwt. of seed cotton, and gin processing cost is entered as $2.75/cwt. of seed cotton. To obtain a head-to-head comparison for the three varieties at Lubbock, the user selects "Variety" as the comparison. The user clicks "Next" to enter planting seed cost information. The user enters 40 inch row spacing and 4 seed per row foot. The number of seed per bag and the per-bag seed costs and technology fees are entered as shown in Fig. 3 (this information is for 2008 as reported by Plains Cotton Growers, Inc.). A maximum per-acre technology cap of $17 is entered for the two Roundup Ready varieties (if there's not a technology cap, enter 999). Additional weed management costs for a conventional variety compared to a Roundup Ready variety require the user to include $17/acre for "Other Costs" for the conventional

variety. The user clicks "Calculate" to calculate specified costs, and then clicks the Head-to-Head Results tab to view the results on sheet 3.

Sheet 3, Head-to-Head Results—The results sheet displays a table of head-to-head results for the three varieties selected by the user (Fig. 4). Economic information is provided on lint and seed revenue, total revenue, mean net revenue and variability, costs, lint premiums and discounts, etc. Agronomic information is provided on lint yield, fiber length, micronaire, fiber strength, color grade, seed yield, seed grade, oil and nitrogen percent of seed, etc. The complete head-to-head results table from this example is shown in Table 1. To graph the results, the user clicks on the "Graph" tab and moves to sheet 4.

Sheet 4, Graph—This sheet is where the user generates graphs of the information presented in the head-to-head results table. The user can select one or more variables from the "Available Variables" box for graphing.

Using the information generated by the Cotton Wizard application, the user can select a variety to plant. In this example, FiberMax 958 has the highest mean net revenue (MNR), and the highest coefficient of variation (CV). NexGen 2448RR has slightly lower MNR ($15/acre less) but considerably lower risk as measured by the CV (13.3% for NexGen 2448RR compared to 18.7% for FiberMax 958). A producer who prefers the lowest risk can choose All-Tex Atlas RR because it has the lowest CV of 9.0%; however, it has the lowest MNR of $804/acre compared to $933/acre for FiberMax 958 and $918/acre for NexGen 2448RR. The graph on sheet 4 shows the relationship between mean net revenue and standard deviation (Fig. 5). Producers may consider factors other than MNR and CV when selecting a variety. For example, NexGen 2448RR has the highest seed yield and seed quality, whereas FiberMax 958 has the highest lint yield and lint quality.

Stability Analysis—The following is an example of a sample run of a stability analysis for the Cotton Wizard application. As in the previous example, the user first selects the dataset for analysis from the Data Selection pane. The user selects OVT data for six irrigated cotton varieties grown at Lubbock, TX, from 2003 to 2008 (left pane of Fig. 6). The variables selected for analysis are lint yield, lint turnout, seed yield, seed grade, and loan PD. At the bottom of the pane, the user checks "Avg of Reps" to obtain average of the replications of the data (stability analysis requires average data). The user clicks the Query button to create the dataset for analysis.

Next, the user clicks on the "Prices and Costs" tab and enters information on base prices for lint and seed, harvest and ginning costs, and planting seed cost information (see the previous example for details on the Prices and Costs sheet). The user skips the Head-to-Head Results sheet and Graph sheet and clicks on the Stability Analysis tab. From the "Available Variables" box, the user selects Net Revenue as the variable for stability analysis (only one variable can be selected at a time). The user then selects three varieties for the stability graph (a maximum of four varieties can be shown on one stability graph) and clicks the "Show Graph" button to obtain the stability graph in the right pane of Fig. 6.

The stability graph shows that across all environments FiberMax 958 and FiberMax 958LL have higher Net Revenue than All-Tex Atlas RR—thus, All-Tex Atlas RR should be eliminated from consideration. When comparing FiberMax 958 to FiberMax 958LL, the choice depends on the environment. If the decision-maker anticipates a high-yield environment, FiberMax 958LL is the preferred variety, whereas for a low-yield environment the two varieties achieve approximately equal Net Revenue. Forecasting the type of environment for a growing season is difficult. Nevertheless, a producer can attempt to forecast the growing season environment using

pre-plant soil moisture data and weather forecasts, and then select a preferred variety for the anticipated environment.

Variety-by-Location Comparison—The Cotton Wizard application can be used to compare varieties across two or more locations. As an example, FiberMax 958 is selected for comparison at Lubbock and Halfway, TX. This example uses irrigated data for 2000 to 2007. A complete dataset of seven observations is available where FiberMax 958 is planted at both locations in the same year. Based on the head-to-head results in Fig. 7, Part A, FiberMax 958 planted at Lubbock has the higher MNR and the lower CV (as compared to Halfway).

The stability analysis in Fig. 7, Part B provides additional information to determine the preferred location to plant FiberMax 958. In this regard, notice that the stability lines have markedly different slopes for Lubbock and Halfway. The stability lines indicate for a low-yield environment that FiberMax 958 has a higher MNR at Lubbock than at Halfway; whereas for a high-yield environment, FiberMax 958 at Halfway produces a higher MNR. This information is important for a large farming operation that farms in different areas (and even different states) and forecasts the environmental conditions for the growing season. When using stability results to decide on varieties to plant at a farm's multiple locations, the farm manager should consider the pre-plant soil moisture and the anticipated weather conditions for the upcoming growing season at the different locations (Larsen, et al., 2009). In the case of a farming operation that owns farms at Lubbock and Halfway which are only 50 miles apart, it is assumed due to closeness of geographic locations that growing conditions will be similar at each location. In this case, if the farm manager anticipates a low-yield environment, Lubbock would be the preferred location to plant FiberMax 958. By comparison, if a high-yield environment is anticipated, Halfway would be the preferred location for FiberMax 958. In either case, an

alternative variety or crop could be planted at the location where FM 958 was not planted. The stability analysis from this example points out that by strategically choosing planting locations for varieties/crops, a farm manager can potentially reduce variability in overall farm operation return.

Application Objectives

An important objective in creating the Cotton Wizard was to provide a software application for cotton variety selection that solves the logistics problem of analysis of large amounts of data. Additional objectives were to make the application user friendly and as flexible as possible so that a wide range of users could be successfully serviced by the application. The Microsoft **.**Net Framework was found to be appropriate for meeting both objectives due to its ease of use, portability of user knowledge from one application to another, and its enhanced flexibility.

To meet the objective of user friendliness, a graphical and intuitive interface for application operation was created (as described above). Users are asked for all necessary information, and need only learn and remember basic skills to effectively operate the application. Further, the application output was designed for ease of interpretation and manipulation by the user.

To meet the objective of flexibility, several features were designed into the application. First, the application includes a database where the user can view data and download selected data to an Excel spreadsheet for use in other applications. In addition to serving as a database, the Cotton Wizard includes two analytical tools (head-to-head comparison and stability analysis) to aid decision-makers in variety selection. The decision-maker can select from a list of 27 variables to include in the analysis. Per-acre planting seed cost can be calculated for each seed technology and a maximum per-acre technology cap can be set. Finally, the user has the option to include whatever "other costs" are deemed necessary for a particular situation.

A final point to note about the Cotton Wizard application concerns the inclusion of other costs and the interpretation of MNR in variety selection. MNR takes on different meanings, depending on the types of "other costs" supplied by the user on the Prices and Costs sheet. If only costs that differ across varieties are supplied, MNR is useful only for comparing varieties, not for predicting profits. When *all costs* are included, net revenue represents the expected accounting profit; or if only *variable costs* are included, net revenue represents a contribution margin (i.e., return to fixed assets).

SYSTEM REQUIREMENTS AND AVAILABILITY

The requirements to run the Cotton Wizard are specified below.

▪ Microsoft Internet Explorer Web browser with JavaScript, Java, and cookies available.

▪ Microsoft Windows operating system (Windows 2000 (SP3+), Windows XP (SP2+),

  Windows Vista, or Windows 7).

▪ Microsoft Excel (to receive downloaded data).

The Cotton Wizard application was written in C# based on the Microsoft **.**NET Framework SDK v2.0 and Microsoft ASP**.**NET 2.0 AJAX Extensions. The dataset is in Microsoft Access format. Microsoft Access and **.**Net Environment are not required for system use.

Documentation of the Cotton Wizard application is provided in the *User's Manual for the Cotton Wizard*. The documentation includes details on how to use the application and the options available in the application. A complete explanation of the calculations made by the application is also provided in the documentation. The *User's Manual* is distributed online.

The Cotton Wizard application can be accessed at: http://www.aaec.ttu.edu/cottonwizard. Updated data sets will be available every year as new performance test data are published by the

Texas A&M AgriLife Research and Extension Center (Dever, et al., 2009) and the National Cotton Variety Testing Program (USDA, ARS).

DISCUSSION

Cotton growers achieve profitable returns by controlling production costs and by producing high yielding crops having high quality lint and seed. The foundation of a profitable cotton farming operation is variety selection. In the traditional approach to variety selection, varieties are compared based on lint yield and fiber quality characteristics obtained from performance test data from Official State Variety Trials. This approach is appropriate for situations where the production program and production costs are similar across varieties; however, it is not the best approach when the production program and costs cannot be assumed to be similar across varieties, such as when transgenic varieties are compared with conventional varieties.

The proliferation of transgenic cotton varieties (Roundup Ready, Roundup Ready Flex, and Liberty Link herbicide-resistant and Bollgard, Bollgard II, and WideStrike insect-resistant types and stacked-gene types) calls for new approaches to variety selection (May et al., 1999; May, 2000). Traditional experimental-plot variety testing programs involve evaluation of genetic components but not genetics in concert with production management programs. Because transgenic varieties have different value-added traits, each variety must be evaluated under its appropriate management program with differing input levels, cultivation practices, etc. For example, Bt cotton varieties have built-in pest controls. When comparing a Bt variety with a conventional variety, the conventional variety should be grown with a comparable pest management program to that of the Bt variety (i.e., one that provides a level of pest control equal to that of the Bt variety). In this situation, varietal comparisons involve an economic analysis of the costs of the respective pest management programs. When using the Cotton Wizard

application, specific costs for each pest management program can be included in "Other Costs" on the Prices and Costs sheet of the program (Fig. 3).

The Transgenic Evaluation Working Group (May, et al, 1999) proposed guidelines on how to conduct Official State Variety Trials and how to evaluate and select cotton varieties when transgenic varieties are involved:

The evaluation process should estimate net returns for all cultivars in a manner specific for the production system intended for use with the cultivar, that is by systems testing. *By systems testing, we mean growing the test-cultivars in replicated field trials, using the respective management programs that are appropriate for the individual cultivars, and recording pest management efficacy and costs, cotton lint and seed yields, and fiber quality.* These data would then be used to calculate gross returns, and returns above pest management costs, or other such costs as may be relevant for other types of transgenic varieties.

The above guidelines suggest that growers can no longer focus on single characteristics (such as lint yield) when evaluating transgenic varieties. Variety evaluation and selection now involves the entire varietal, input-output package including lint and seed yield, quality characteristics, and the input management program. In this situation, the Transgenic Evaluation Working Group recommends that economic returns above costs should be calculated using variety performance test data. In this new paradigm, economics is used to obtain a common unit of measurement by converting physical varietal characteristics (lint yield, fiber strength, seed yield, oil percent, etc.) and production programs (spray materials and application cost, weed control, seed technology fee, etc.) into dollar values in terms of gross revenue, production costs, and net return data. The use of net return is appealing because it incorporates multiple aspects of

a variety—including yield and quality characteristics (gross revenue) and the management program (production costs)—into a single monetary value (Antle and Wagenet, 1995). Following this new paradigm, the Cotton Wizard software application can be used in variety selection to calculate net returns for transgenic and non-transgenic varieties that require specific management programs and produce lint and seed with different quality characteristics.

Although the Cotton Wizard application was primarily designed for variety selection, there are alternative uses. It can be used for data display and analysis (tables and graphs) to facilitate the interpretation and presentation of available information. This use is relevant to local agricultural experiment stations and the National Cotton Variety Testing Program that publish large amounts of variety performance data. Agronomists and technicians in agricultural experiment stations can use the program for comparison of different seed treatments, fertilizer levels, irrigation systems and schedules, and other managerial practices. The software can be used in economic analysis of cotton production, including the seed component, which has largely been ignored in previous research. Further, the Cotton Wizard application can be used to determine the impact of ignoring seed quantity and quality on producer net revenue and variety selection.

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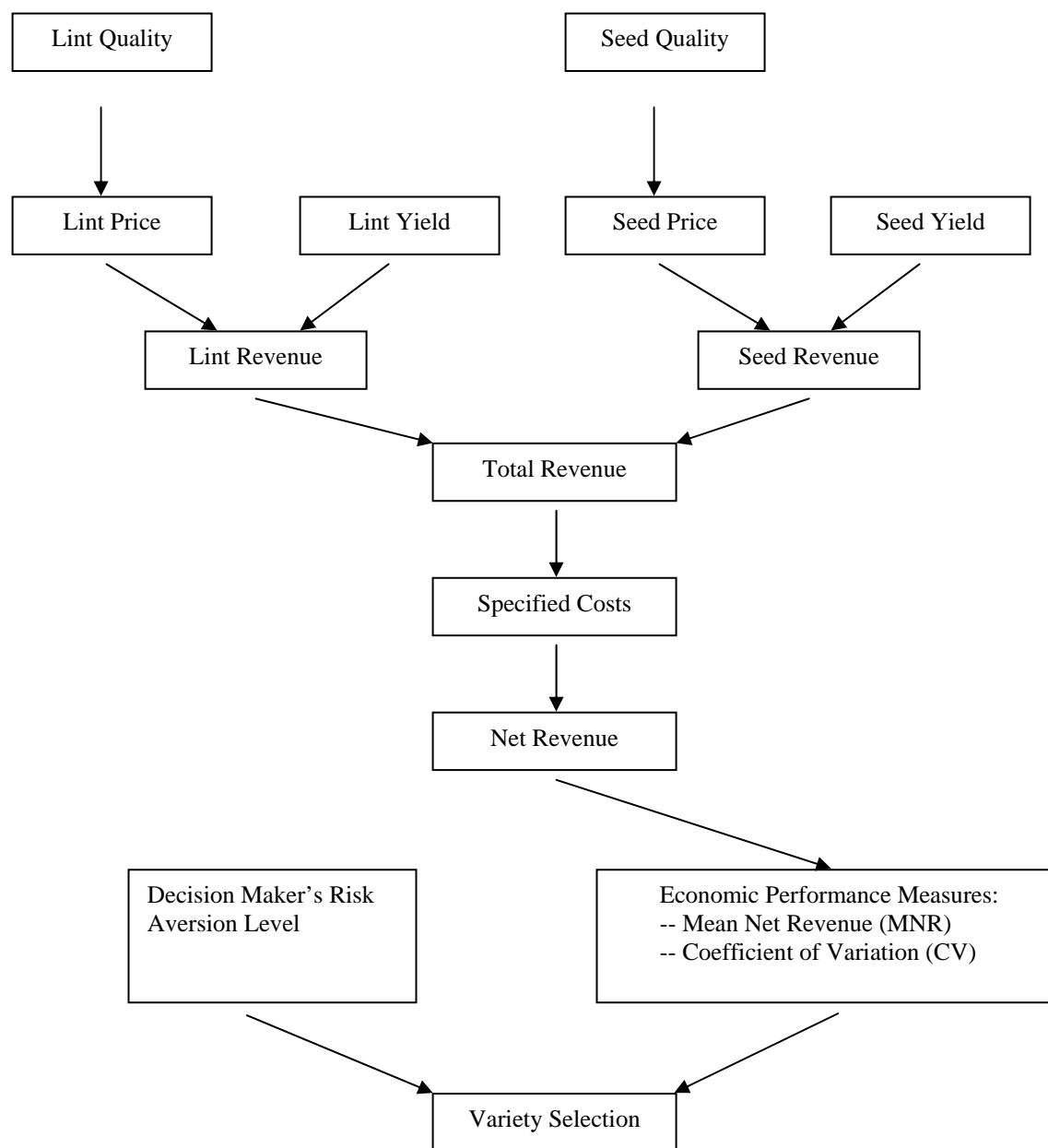
Fig. 1. Diagram of the cotton variety selection model.

Fig. 2. Data selection pane and sheet 1—dataset.

Fig. 3. Sheet 2—prices and costs.

Cotton Wizard: A Cotton/Cottonseed Variety Selection Application　　　User's Mannual

DataSet | Prices&Costs | Head-to-Head Results | Graph | Stability Analysis

Experimental Test Type:
☑ OVT ☐ Late Planted ☐ RRflex

Technology:
☐ B ☐ B2 ☐ B2LL ☐ B2R ☐ B2RF ☐ BR ☐ BXN ☐ BXNB
☑ Conv ☑ LL ☐ Null ☑ R ☐ RF ☐ W ☐ WR ☐ WRF

Irrigation:
☑ Irrigated ☐ Dryland

Years for Analysis: 2005 ▾ To 2008 ▾

State: TX / Select All
Location: Pecos / Lubbock / Halfway / Tulia / Lamesa / Select All

Available Varieties:
NG 1553RR
NG 3969RR
PHY 310R
PHY 72 Acala
PM 183
PM 2167RR

Selected Varities:
All-Tex Atlas RR
FM 958
NG 2448RR

Available Variables: *
LintPicked_Pct
LintPulled_Pct
BollSize
LinIndex
OpenBolls_Pct
StormResistance
Elongation
Loan_Val
PGossy
MGossy

Selected Variables:
Rd
HpB
LeafIndex
Color_Gr
Loan_PD
SeedYield
SeedTurnout_Pct
SeedIndex
Seed_Per_Boll
Oil
Nitrogen
Gossy
Seed_Gr

Up / Dn

* If you intend to run a Head-to-Head comparison, follow these steps: (1) Select the following five variables from the Available Variables box: LintYield, LintTurnout, SeedYield, Seed_Gr and Loan_PD. (2) Check the

☑ Avg of Reps ☐ Sort Desc　Query

Econ & Agro Info	Obs.	All-Tex Atlas RR	FM 958	NG 2448RR	F-stat	p<.05	LSD
Lint Rev ($/ac)	4	835.47	1000.26	950.42	1.45		224.47
Sd Rev ($/ac)	4	194.75	186.22	213.8	1.6		35.75
Total Rev ($/ac)	4	1030.21	1186.48	1164.22	1.11		256.63
Sp Costs ($/ac)	4	226.14	253.05	245.86	0		0
Net Rev ($/ac)	4	804.07	933.43	918.36	1.18		208.13
Std.Dev.of NR ($/ac)	4	72.57	174.94	122.15	0		0
Coef.of Var.of NR (%)	0	9.03	18.74	13.3	0		0
Lint Yld (lb/ac)	4	1234	1425	1400	1		325
Lint Turnout %	4	27.3	29.3	28.6	5	*	1.4
Fb Str (g/tex)	4	28.2	30.3	29.9	2.4		2.2
Mic	4	4.2	4.2	4.2	0.1		0.4
Fb Lngth (in)	4	1.08	1.14	1.08	6.76	*	0.04
Unif %	4	81.3	81.5	82.6	4		1.1
Rd	4	78.1	79.8	76.8	4.6	*	2.2
HpB	4	7.9	7.7	8.1	2.2		0.5
Leaf Indx	4	2.3	2.4	2.4	0		1.8
Loan PD	4	279	525	274	3		282
Sd Yld (lb/ac)	4	2102	2060	2290	1		449
Sd Turnout %	4	46.3	42.2	45.9	10	*	2.3
Sd Indx (g)	4	10.7	10.7	10.5	0.2		0.9
Sd per Boll	4	31	26.6	28.4	2.1		4.8

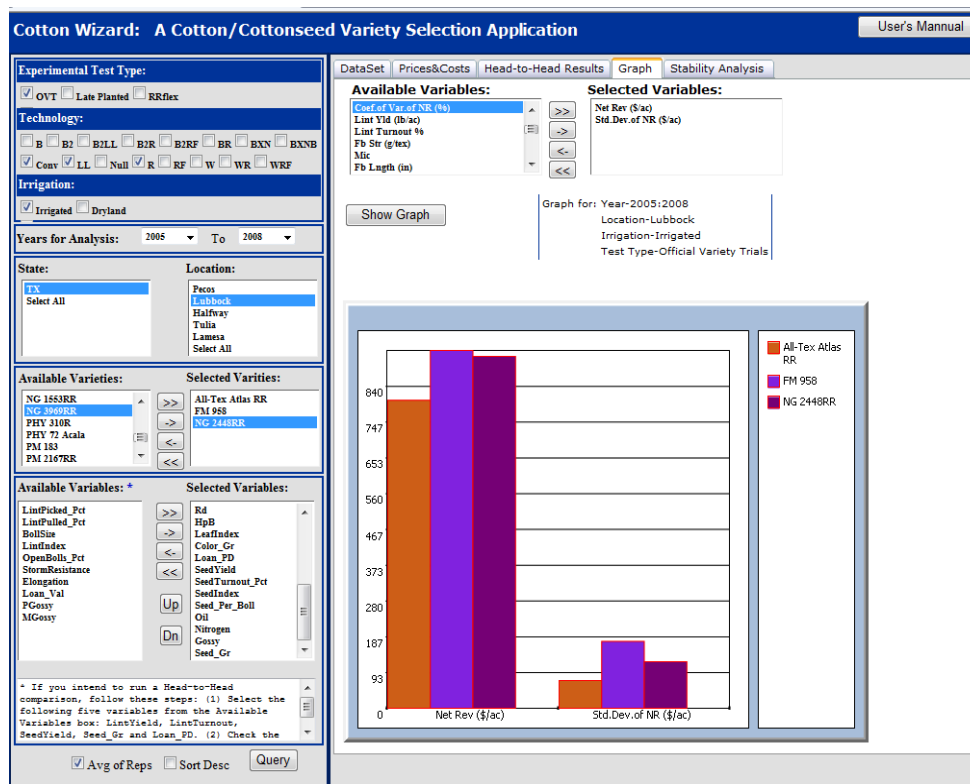Fig. 4. Sheet 3—head-to-head results.
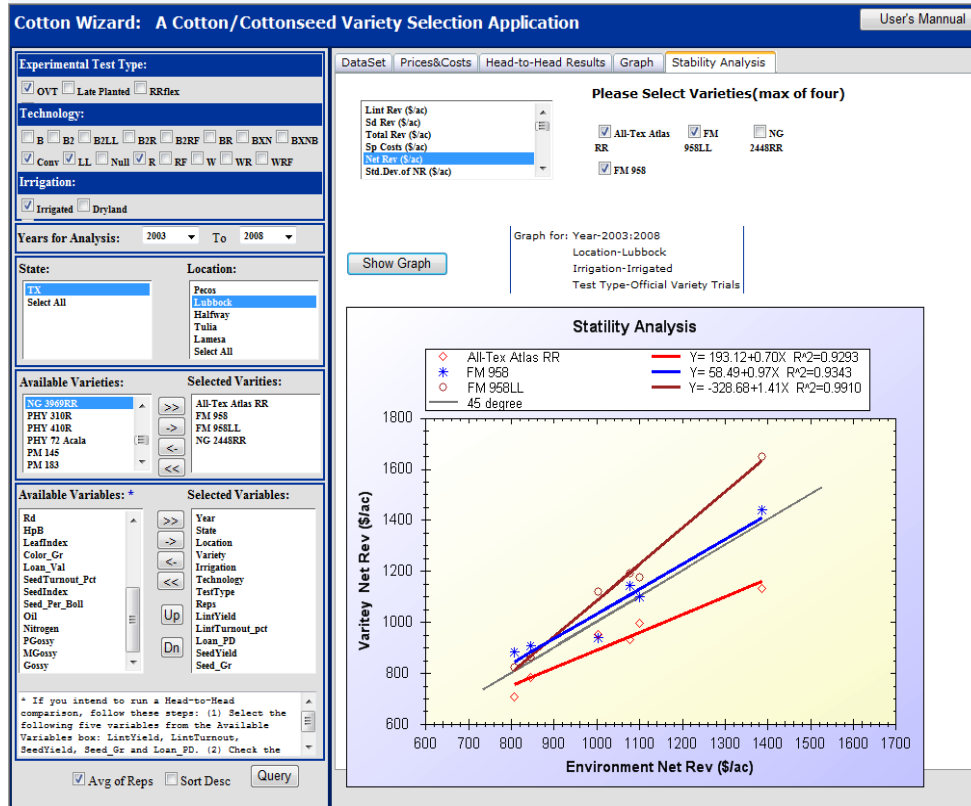
Fig. 5. Sheet 4—graph.

Fig. 6. Sheet 5—stability analysis.

A: Head-to-head results sheet:

| Econ & Agro Info	Obs.	FM 958Halfway	FM 958Lubbock	F-stat	p<.05	LSD
Lint Rev ($/ac)	7	675.77	687.99	0.01		259.71
Sd Rev ($/ac)	7	127.06	121.77	0.1		37.14
Total Rev ($/ac)	7	802.83	809.76	0		294.98
Sp Costs ($/ac)	7	169.3	164.65	0		0
Net Rev ($/ac)	7	633.54	645.12	0.01		259.64
Std.Dev.of NR ($/ac)	7	286.98	130.56	0		0
Coef.of Var.of NR (%)	0	45.3	20.24	0		0
Lint Yld (lb/ac)	7	1070	1098	0		343.9
Lint Turnout %	7	26.7	28.6	1.8		3.13
Loan PD	7	176	243	0		617.06
Sd Yld (lb/ac)	7	1694	1628	0		491.78
Seed Gr	7	100	99.7	0.2		1.58

B: Stability analysis sheet:
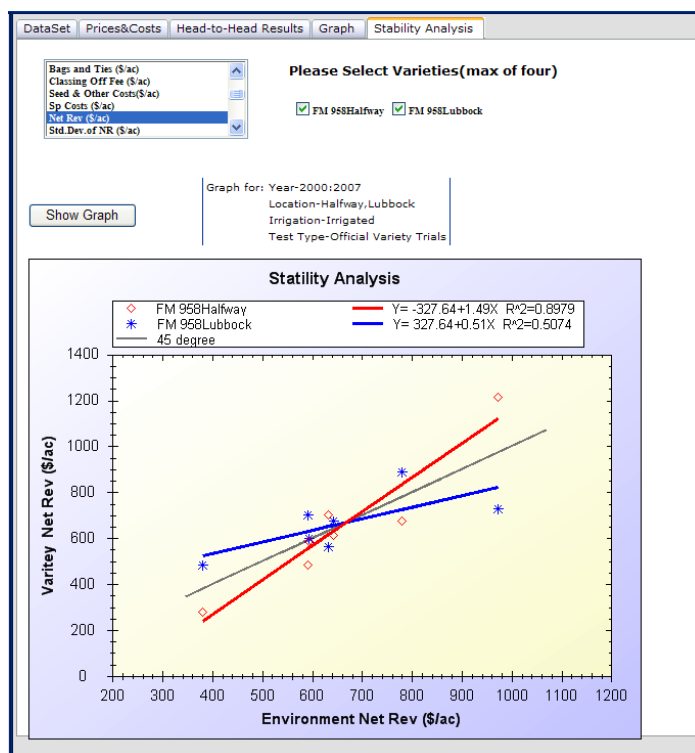
Figure 7. Variety-by-location comparison.

Table 1. Economic and agronomic results for Lubbock irrigated cotton, 2005-2008 averages.

Economic and agronomic infor.	No. obs.	All-Tex Atlas RR	FiberMax 958	NexGen 2448RR	F-stat	LSD
Lint revenue (LR), $/ac	4	835.47	1000.26	950.42	1.45	224.47
Seed revenue (SR), $/ac	4	194.75	186.22	213.80	1.60	35.75
Total revenue (TR), $/ac	4	1030.21	1186.48	1164.22	1.11	256.63
Specified costs (COSTS), $/ac	4	226.14	253.05	245.86	--	--
Net revenue (NR), $/ac	4	804.07	933.43	918.36	1.18	208.13
Std. dev. of NR, $/ac	4	72.57	174.94	122.15	--	--
Coef. of var. of NR, %	4	9.0	18.7	13.3	--	--
Lint yield, lb/acre	4	1234.	1425.	1400.	1.00	325.
Lint turnout %	4	27.3	29.3	28.6	5.00*	1.4
Fiber strength, g/tex	4	28.2	30.3	29.9	2.40	2.2
Micronaire	4	4.2	4.2	4.2	0.10	0.4
Fiber length, 32s inch	4	1.08	1.14	1.08	6.76*	0.04
Length uniformity, %	4	81.3	81.5	82.6	4.00	1.1
Rd (reflectance), %	4	78.1	79.8	76.8	4.60*	2.2
Hunters +b (yellowness)	4	7.9	7.7	8.1	2.20	0.5
Leaf index	4	2.3	2.4	2.4	0.44	1.8
Color grade	4	31-1	21-2	31-2	--	--
Loan PD, pts/lb	4	279.	525.	274.	3.00	282.
Seed yield, lb/acre	4	2102.	2060.	2290.	1.00	449
Seed turnout %	4	46.3	42.2	45.9	10.00*	2.3
Seed index, g	4	10.7	10.7	10.5	0.20	0.9
Seed per boll	3	31.0	26.6	28.4	2.10	4.8
Oil % (dry basis)	3	21.30	20.39	21.43	4.33	0.94
Nitrogen % (dry basis)	3	3.74	3.72	3.87	3.52	0.15
Total gossypol %	3	1.47	1.02	1.43	4.03	0.43
Seed grade	3	103.1	100.5	104.0	2.10	4.0