MANAGING PRODUCTION COSTS VARIETIES: CONVENTIONAL OR TRANSGENIC?

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Abstract

Selecting the most appropriate varieties can be a complex process that involves evaluation of numerous factors. First and foremost, both conventional and transgenic varieties must have good yield potential, be adapted to the production region and produce fiber of acceptable quality. Transgenic varieties with value added traits such as insect and herbicide resistance must be further evaluated in different production regions for their potential to offset higher seed costs and licensing fees. Conventional and transgenic varieties must also possess available genetic disease and nematode tolerance, boll types and other characteristics necessary for optimal production. Results from public and private variety evaluation trials conducted over years and locations provide good indicators of performance on which to base varietal selections. Since public testing of the transgenic varieties is still limited, growers must also rely on results from industry trials, comparisons of yield and quality characteristics with the parent varieties and their own experiences and observations.

Introduction

Variety selection is an important management decision that can contribute to reduced per unit production costs. Private and public breeders have done an excellent job in developing high yielding, well adapted varieties that produce quality fiber and exhibit varying levels of tolerance to disease, nematode and insect pests and to abiotic stresses such as drought and salinity. Earlier studies (Bridge and Meredith, 1983) have shown that from 1910 to 1979, the yielding ability of cotton cultivars was steadily enhanced through genetic improvements. More recently, however, Meredith (Savoy and McCarty, 1997) noted that the industry has not seen any major yield increases in the last 10 years, possibly due to shifting of breeding emphasis from yield performance to emphasis on the development of transgenic varieties with insect and herbicide resistance.

Much of the improvement in yields has been attributed to greater partitioning of dry matter into reproductive structures (Wells and Meredith, 1984). Within the last 20 years or so, conventional varieties have tended to become shorter statured, more compact and earlier maturing as well as more productive (Bridge and McDonald, 1987). The quality of cotton produced in the U.S. has also shown improvements which are due in part to varietal improvements and in part to use of better management practices (Sasser and Shane, 1996).

The advent of genetic engineering provided an important new tool for variety improvement and has led to the development of "transgenic cottons" that became commercially available in recent years. Development of transgenic cottons involves the isolation and transfer of one or more genes from a transgenic donor parent to an existing variety by a backcrossing method (Wrona et al. 1997). Unlike conventional breeding procedures which only allow for the transfer of traits from closely related relatives, genetic engineering allows the introduction of genes from species unrelated to cotton. This techniques is said to be faster than conventional breeding and introduces known "value added" traits to an existing variety. Typically, the agronomic and fiber quality characteristics of the "new" transgenic varieties differ somewhat from the original variety (recurrent parent) due to selections made during the three or more backcrosses. For the coming growing season, commercially available transgenic cottons will include varieties that possess Bollgard (BG), Roundup Ready (RR), BG + RR, BXN and BXN + BG genes.

Variety Selection Criteria

For 1998, cotton growers will have a wide array of conventional and transgenic varieties from which to chose. Factors that growers should consider in making variety selections include the following:

* Yield potential
* Adaptability
* Fiber properties
* "Value added" traits
* Disease tolerance/resistance
* Boll type (stormproofness)
* Pubescence (hairiness)
* Others

Yield is regarded as the most important component of the "profitability equation." The attainment of a variety's yield potential is dependent on many factors including its adaptation to the region in which it is being grown, the cultural practices used and the sufficiency of various inputs applied including water, nutrients and pest control.

Adaptability is a reflection of those inherent traits or characteristics that contribute to the consistency and stability of performance of a variety in a given region. Such traits include maturity (earliness), greater ability to withstand short periods of drought and plant type that is suited to the tillage system being used (i.e. ultra narrow row). Well adapted varieties tend to perform satisfactorily in good as well as poor production years.

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Fiber quality also contributes to profitability. Length, strength and micronaire are largely inherited traits that are important because of the economic value associated with each. The relative importance (and value) of these properties is dependent in part on the spinning method used to produce the yarn and the type of fabric produced from the yarn. Leaf grades may be adversely affected by pubescence or hairiness (Anthony, 1990). Other genetic traits which may affect performance at the mills but which do not currently have a stated economic value include elongation and short fiber content.

The value added traits that will be available in transgenic cottons for 1998 include BG, RR, BG + RR, BXN and BXN + BG. These traits will be available in a greater number of varieties, some of which should be better adapted in certain production regions than were the earlier releases. Seed costs of all the transgenics tend to be higher than those of the conventional varieties and additional per acre licensing fees are associated with varieties that contain the BG and RR genes. These are "up-front" costs which must be weighed against the probability of receiving a direct economic benefit from use of the transgenic over the conventional variety.

Benedict (1996) surmised that the greatest opportunity to increase profits with BG technology would be in production regions where more than $30 per acre was spent to control bollworms, tobacco budworms and pink bollworms. In Mississippi, Gibson et al. (1997) reported that although the savings from the use of BG cotton will vary from year to year, early indications are that the bt cotton will provide higher net returns for producers. Others have shown that use of BG technology can be profitable even in areas where insecticide savings are insufficient to cover seed and license fee costs if the transgenic varieties consistently produce higher yields (Bryant et al., 1997).

In contrast, a well adapted conventional variety with higher yield potential than a transgenic counterpart with the BG gene could have the economic advantage even though it required more frequent insect control treatments. Other factors that warrant consideration in selecting a transgenic with BG over conventional varieties include growing cotton in boll weevil eradication zones, need to control mid to late season infestations of aphid and whiteflies and delayed planting or other factors that increase the risk of heavy tobacco budworm or pink bollworm infestations.

RR and BXN technology provides a means to control certain problem weeds, reduce herbicide, hoeing and tillage costs and reduce injury from supplemental pre-emergence and post directed herbicide applications. It also expands opportunities for adoption of reduced tillage and ultra narrow row production systems. Both the RR and BXN systems, however, have some limitations. For example, with the RR varieties, Roundup Ultra must be applied on or before the 4th true leaf stage of growth. BXN cotton is highly tolerant to Buctril but the herbicide is only moderately effective on some weed species (i.e. pigweed). For the most part, the herbicide tolerant cottons will be used to compliment rather than replace existing weed management practices. Again, higher seed costs, licensing fees (with the RR and BG + RR varieties) and the limitations of the herbicide resistant cottons must be considered in establishing the cost effectiveness of their use.

Transgenic cotton varieties have a definite place in many production systems. But, their limitations must be recognized and good management decisions must be made in order to reap positive benefits from their use (McCarty, 1997).

Plant breeder have also made significant improvements in incorporating host plant resistance to various diseases into adapted commercial varieties. Ranney (1995) reports that on a national basis, losses from all diseases declined over 30% during the 1961-1993 period. When comparing differences between the 1961-1965 and 1989-1993 periods, he noted that the reduction in losses for diseases without host plant resistance was about 21%. When the same comparisons were made for diseases controlled with genetic resistance, the reduction in losses was 61%. Varying levels of genetic resistance have been identified for bacterial blight, Fusarium wilt, Verticillium wilt and nematodes. In fields where the wilt diseases and/or nematodes are a problem, resistant varieties (coupled with supplemental chemical control measures for nematodes) provide cost effective control.

Stormproof bolls can minimize seed cotton losses, especially in stripper harvest areas. However, "tight bolls" can reduce picker efficiencies and necessitate a costly second picking. For the most part, breeders have done a good job of incorporating boll types into commercial varieties that minimize field losses but are suited for harvest with spindle pickers. Other considerations that may impact variety selection include plant responses to fertilizers, plant growth regulators and harvest aids (Gannaway, 1995).

Assessing Varietal Performance

Most states conduct local, statewide and regional cotton variety tests which provide a wealth of information about yield potential, adaptability, fiber quality and other varietal characteristics. Additionally, many county Extension agents and specialists conduct on-farm variety tests to assess the performance of promising new as well as established varieties. Prior to 1997, most of these trials were limited to evaluations of conventional varieties. Data from test reports can be helpful in selecting high yielding varieties with the desired fiber quality traits.

When the information is available, especially from trials conducted locally, consider the yield performance over a 3+ year period and select varieties that are consistently in the top

25%. In addition to high yield potential, this indicates that these varieties are well adapted to the region and able to perform satisfactorily under varied growing conditions. Checking the fiber characteristics in variety test reports can insure that a variety can produce the quality of fiber needed to meet contract specifications or to forewarn producers about potential problems with certain quality traits (i.e. high micronaire).

Typically disease and nematode tolerance evaluations are made in separate tests conducted in plots know to be highly infested with the disease organism. Varieties that show good tolerance or resistance to diseases and/or nematodes and also perform well in the variety trials are excellent candidates for use on farms infested with these pests.

Currently test data on performance of the transgenic varieties is not as readily available as that for conventional varieties. Although transgenics have been tested for several years, most have been in-house industry trials. Until recently, most public trials were conducted to evaluate the "value added" trait more so than the agronomic performance of the cultivar. In 1997, commercial seed companies began to enter more transgenic cultivars in stateand regional trials. Consequently, in assessing varietal performance relative to yield, adaptability and fiber quality, it may be more meaningful to look at performance over several locations rather than just considering the results derived at a nearby test site.

Yield and quality characteristics of the (recurrent) parent variety may provide some indication of performance although, as noted above, marked differences--positive and negative--can occur between the two varieties. Generally, the transgenic cultivars are reported (by the companies) to have equal or better yield potentials and fiber characteristics than the original varieties but the plant types, boll types and other characteristics may differ. Evaluations and observations made on-farm by growers are also good sources of information about the performance and adaptability of transgenic varieties.

Recently, a computer model dubbed the "Cotton Wizard" was developed to assist decision makers with variety selections (Beddow, et. al., 1997). The program uses variety test data generated by various sources across the U.S. Cotton Belt and the decision criteria are based on expected economic returns and other factors.

Summary

Variety selection is an important but not the only management decision that impacts per unit production costs and ultimately profitability. First and foremost, both the conventional and transgenic varieties must have good yield potential and be well adapted to the production region. Value added traits such as BG, RR, BXN or combinations thereof must be evaluated for their potential to reduce production costs, to maintain or increase yields and to produce the quality of fiber demanded by the market place. Conventional and transgenic varieties must also possess available genetic disease and nematode tolerances, boll types and other characteristics necessary for optimal performance in various production regions. Test results, especially over years and locations, provide good indicators of performance of both conventional and transgenic varieties. The ultimate evaluation, however, comes from on-farm performance and producers are encouraged to test new varieties on a regular basis. Limit the acreage of "test plots" with unproven varieties and design the test to make objective comparisons. A good management practice is to plant two or more varieties each year. Select varieties to accommodate soil types, planting dates and other factors and thereby reduce the risk of selecting the "wrong" variety. Above all, avoid "betting the farm" on one variety--especially a new one that hasn't been extensively tested or grown in the area.

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