ARKANSAS COTTON: STAGNANT YIELD AND INCREASED RISK?

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RESEARCH PROBLEM

Trend line analysis of annual yield data collected by the Arkansas Agricultural Statistics Service (AASS) is being conducted in order to (1) determine whether Arkansas cotton has experienced significant yield increases in the recent past and (2) quantify yield risk associated with cotton production in the state. This information is important for producers because the 1996 Farm Bill has placed increased attention on the need for risk management information in decision-making.

BACKGROUND INFORMATION

Cotton is an important crop for Arkansas. In 1998, it generated 9.5% of the state's total farm cash receipts, and Arkansas ranked fifth in U.S. cotton production. Because of low prices in recent years, cotton producers are increasingly concerned about yield, profit, and risk. This study analyzes cotton yield in Arkansas for trend and risk. In particular, it examines two issues: First, is cotton yield in the state increasing over time, and second, is cotton yield becoming less variable (i.e., less risky) in recent years. In periods of depressed prices, increased yield and/or reduced yield risk provide potential relief for producers who are trying to maintain a stable farm income.

METHODS

Historical state-level yield data for "all" cotton (i.e., irrigated and dryland) were obtained from the AASS for the period 1965 through 1999. The 35-year data set was analyzed both as a whole, and as a series of six 10-year subsamples with 5-year overlaps (1965-1974; 1970-1979, 1975-1984, 1980-1989, 1985-1994, 1990-1999). The 10-year subsamples were arbitrarily defined in order to evaluate and compare trend and risk within the 35-year period. Ordinary least squares (OLS) linear trendline regressions were estimated for each subsample with yield and year as dependent and independent variables, respectively. Moreover, regression analysis was performed on the 35-year data set to evaluate the long-term trend of cotton yield in Arkansas. A trendline "expected" yield (TLY) for each data subsample was computed as the predicted yield at the endpoint of each regression trendline (i.e., 1974, 1979, 1984, 1989, 1994, and 1999 for each of the 10-year regressions and 1999 as the endpoint for the 35-year

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regression). Subsequently, an *absolute* measure of risk associated with each period was measured as the root mean square error (RMSE) around each regression trendline. Finally, a trendline coefficient of variation (CV) was computed for each subsample by dividing each trendline RMSE by its corresponding TLY. Each trendline CV measures the *relative* yield risk within each data subsample.

RESULTS

Yield Trend

A scatterplot containing the raw data, the six 10-year trendlines, and the 35-year trendline was constructed (Fig. 1). The 35-year trendline suggests that Arkansas cotton yield increased consistently between 1965 and 1999. However, closer inspection of the individual trendlines for each of six 10-year periods indicates that most of the yield increase occurred in the middle of the 35-year period. Slopes of the subsample trendlines appear to be virtually flat before the mid-1970s and after 1990.

The trendline regression statistics are summarized in Table 1. The slope coefficients indicate the rates of change, i.e., the yield trend of Arkansas cotton during each selected period. Thus, over the long-run (1965-1999), the yield of Arkansas cotton increased, on average, by 11 lb/acre/year. This slope coefficient (or yield trend) is statistically significant at the 0.01-level. In contrast, the slope coefficients for 1965-74, 1970-79, and 1990-99 were slightly negative suggesting very small decreases in Arkansas cotton yield during each of those periods, but they are not statistically different from zero. Consequently, during the late 1960s, the 1970s, and the 1990s, Arkansas cotton yield experienced notable periods of stagnation. Likewise, the positive slope coefficient for 1985-94 was not statistically significant.

Consistent with Fig. 1, the 1980s represented a decade of extraordinary growth in yield. In fact, the only subsamples with statistically significant slope coefficients were 1975-84 and 1980-89. Cotton yield in Arkansas grew, on average, by over 18 lb/acre/yr between 1975-84 and by almost 35 lb/acre/yr between 1980 and 1989.

Yield Risk

Although the RMSE of Arkansas cotton yield decreased slightly in the 1970s (Table 1), it reversed its direction and increased steadily from 64 lb/acre in 1970-79 to 112 lb/acre in 1990-99. Thus, "absolute" cotton yield variability—i.e., risk—rose by 75% in Arkansas between these time intervals. Because this increase in risk was accompanied by higher average yield levels over the same period, it conforms to the principle "higher returns bring higher risk." However, the "relative" cotton yield risk, as measured by the trendline CV in Table 1, increased to over 15% in 1990-99 after declining to 12% in the 1980s. This indicates that, relative to average yield levels, yield risk in the 1990s was proportionately greater than in the 1980s, but still less than in two earlier periods (1965-74 and 1975-84).

DISCUSSION

During the 35-year study period, the decade of the 1980s was undoubtedly the

period with the most dramatic growth in Arkansas cotton yield. The obvious question that poses itself is, Why?

One factor that probably explains some of the marked increase in the yield during the 1980s is irrigation. After experiencing an extremely dry year in 1980, Arkansas producers started to favor irrigated cotton, replacing their dryland systems. This phenomenon was observed throughout the 1980s. Indeed, the share of irrigated cotton acreage in Arkansas rose from 14.5% in 1980 to 43% in 1990, a threefold increase. The acreage devoted to irrigated cotton in Arkansas has continued to grow in the 1990s.

Since cotton is relatively susceptible to pests, the development of new pesticides has typically played an important role in yield improvement of this crop. During the late 1970s and early 1980s, a number of cotton pesticides were developed and introduced into the market. In particular, pyrethroids (e.g., Pounce, Pydrin, Ambush) which were highly effective as well as cost efficient came into wide use by cotton producers. In addition to new pesticides, cotton farmers benefited from the introduction of the so-called fast-fruiting varieties in the 1980s. Each of these factors may have contributed to the improved yield which is evident in the middle years of the study period in Figure 1.

During the late 1990s, the emphasis of plant breeders and genetic engineers has been to develop crops with genetically improved traits, e.g., Roundup Ready and BXN cotton, and *Bacillus thuringiensis* cotton. However, these transgenic crops are not a technology which has specifically targeted yield increase as their main objective. Rather, their primary purpose is to improve pest management through reduced weed and insect pressure. Unfortunately, due to their relatively recent adoption by producers, the impact of transgenic crops on yield may not be evident in the statewide yield data used in this research.

PRACTICAL APPLICATION

The phaseout of government deficiency payments, which began with the 1996 Farm Bill, combined with low prices in recent years threaten both the risk and profitability of cotton production. Moreover, trendline analysis shows that in the past decade, stagnant Arkansas state-level yield has been accompanied by increased yield risk. Neither of these observations is likely to provide any comfort for producers who seek to maintain a stable farm income. Consequently, cotton producers must continue to exercise cost-efficient management practices to avoid threats to their financial survival.

Table 1. Trendline regression statistics for Arkansas cotton yield.

Period	Slope coefficient (yield trend)	RMSE[z] (absolute risk)	Trendline CV (relative risk)
	lb/acre/year	lb/acre	%
1965-99	11.05***[y]	100.34	12.89
1) 1965-74	-2.55	77.31	16.87
2) 1970-79	-0.04	63.74	13.48
3) 1975-84	18.32*	91.46	15.57
4) 1980-89	34.92***	94.33	12.05
5) 1985-94	5.11	106.00	14.10
6) 1990-99	-0.59	112.34	15.38

[z] RMSE characterizes the random variability around each linear trendline regression after the systematic variability has been removed.

[y] Single, double,or triple asterisks represent statistical significance at the 0.10, 0.05, or 0.01 levels, respectively.