

# COMPARISON OF ALTERNATIVE KUDZU CONTROL MEASURES ON A BEFORE-TAX BASIS IN MISSISSIPPI

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**Abstract**—Kudzu [*Pueraria montana* var. *lobata* (Willd.)] was initially planted in the Southern United States for a variety of uses. Changing land use and homestead abandonment over time has led to the spread of kudzu across the countryside. The species may now be considered as the original invasive exotic species in the South. Currently, it is believed that kudzu covers more than seven million acres which prevents uses such as timber production and establishment of carbon plantations. Landowners wanting to reclaim these occupied sites need information that examines the biological and economic tradeoffs of alternative control measures. Using data collected on sites in MS, this study examines the financial tradeoffs of controlling kudzu using different herbicide regimes applied by a ground dispersion unit. This analysis is done on a before-tax basis using standard financial criteria. The results suggest that the most cost-effective way to control kudzu patches is to spray using Escort XP regardless of patch age.

## INTRODUCTION

Kudzu is a rapid growing, trailing or climbing, semi-woody vine native to Japan, China, Taiwan, and India. It has been used in its native range for medicinal purposes, fiber production, and food for more than 2000 years. Kudzu was first introduced to the United States in 1876 as an ornamental vine at the Philadelphia Centennial Exposition (Shurtleff and Aoyagi 1977, Everest and others 1991, Mitich 2000). Farmers became interested in the vine's forage and grazing potential and by the early 1900s it was available through mail order catalogs (Everest and others 1991, Britton and others 2002). The Soil Conservation Service began promoting kudzu as a means of erosion control for many of the abandoned farms of the South in the 1930s. Approximately 85 million kudzu seedlings were planted by farmers and the Civilian Conservation Corps on about three million acres by 1946 (Everest and others 1991). By 1970, the U.S. Department of Agriculture listed kudzu as a weed and in 1997 Congress voted in favor of adding it to the Federal Noxious Weed List (Miller and Edwards 1983, Everest and others 1991).

Current distribution of kudzu extends from eastern TX and OK to the east coast and as far north as VA and MD. However, the most heavily infested areas are in MS, AL, and GA. The goal of this study is to evaluate the financial returns on before-tax basis alternative management regimes that control kudzu and afforest sites into pine plantations for Mississippi. This information will be useful to landowners interested in evaluating the monetary tradeoffs of different approaches to controlling kudzu.

## BACKGROUND

Kudzu vines have been reported growing up to 60 feet in a season and up to 12 inches of growth on a single summer day (Shurtleff and Aoyagi 1977, Everest and others 1991). Roots are woody and quite large reaching sizes of 8 feet in length, 12 inches in width, and weighing up to 400 pounds (Miller and Edwards 1983). Kudzu vines emerge from a root crown into woody stems that can grow to be 0.98 inches thick in 1 to 2 years. Some old vines have reached diameters up

to 3.94 inches. Kudzu can grow and flourish across a wide range of soil types, but it grows best on deep, loamy soils (Everest and others 1991). It can also withstand a wide range of climatic conditions, but it excels in areas with over 39.37 inches of rainfall annually, long growing seasons, warm to hot summers, and mild winters (Shurtleff and Aoyagi 1977).

The aggressive nature of kudzu has caused it to shift from a possible forage crop and means of erosion control to a serious pest and invader of forests, lawns, pastures, and utility rights-of-way. Kudzu out-competes and overtakes practically all vegetation around it, including large trees. As it climbs its way up saplings and trees, kudzu winds around limbs reducing the amount of available sunlight, and may eventually result in death in 2 to 3 years (Mitich 2000, Britton and others 2002). Although no exact figures are known, Mitich (2000) estimates the economic loss due to kudzu encroachment to be in the hundreds of thousands of dollars. Beckwith and Dangerfield (1996) estimate annual losses in forest productivity of \$7.85 per acre per year. Kudzu also climbs power poles, guy wires, and electrical lines where it can cause damage through electrical shorts and even the pulling down of the pole (Shurtleff and Aoyagi 1977). According to Britton and others (2002), Dr. James Miller estimated control costs by power companies alone to be around \$1.5 million per year.

Kudzu is very difficult to control due to both its extensive root and rhizome system and its rapid growth of runners that have the ability to root at the node and create new plants. As the kudzu patch grows older it will become harder to control due to increased root and rhizome biomass. Researchers began to evaluate herbicides for kudzu control in the 1950s when the vine was beginning to be viewed as a threat rather than a beneficial plant. Davis and Funderburk (1964) began testing existing herbicides in 1956 on an old field that had been taken over by kudzu. Using a 1:1 mixture of propylene glycol butyl ether esters of 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) in 200 gallons per acre (gpa) of water at rates of 1, 3, and 5

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Citation for proceedings: Stanturf, John A., ed. 2010. Proceedings of the 14th biennial southern silvicultural research conference. Gen. Tech. Rep. SRS-121. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 614 p.

lbs per acre. Beginning in the mid 1960s, Tordon 10K pellets became the most widely used method of controlling kudzu. Given price increases in Tordon K in the 1980s, the most effective herbicides for treating patches of kudzu were Tordon 10K pellets, Tordon 101 M, and Spike 40P pellets. At the time Spike 40P pellets were still an experimental herbicide and price information was not available, but it was found that applications of Tordon 101 M provided comparable levels of control to Tordon 10K at a much lower cost. However, if controlling kudzu that is draped over trees is necessary, Miller and True (1986) discovered that Garlon 4 was the most effective herbicide. Although herbicide alone has been proven to provide complete control of kudzu, other aspects of integrated pest management such as fire and induced competition control have also been studied.

Through the years Tordon 101 M has proven to be one of the most effective and economical herbicides available for kudzu control (Dickens and Buchanan 1971, Miller 1985, Michael 1986, Miller 1988, Miller 1996). Picloram, the active ingredient in Tordon, has been found to move rapidly through soil and into nearby streams (Michael 1987, Michael and others 1989). Given this, extreme caution should be used when treating kudzu near streams or other bodies of water. Veteran 720 can be used near water as long as it is not directly sprayed on the water. If contact with water is probable Rodeo or Escort may be used; however, repeated applications will be necessary (Everest and others 1991). It is also important to note that for Tordon to be most effective, it needs rainfall 2 to 5 days after it is applied. This will wash the herbicide into the soil where it can be absorbed by the roots (Miller 1996). The suggested application rate for Tordon 101 M is 2 gpa followed by an additional treatment two years later, and spot treatment two years after that (Miller 1996). Dickens and Buchanan (1971) reported that Tordon 101 M was equally effective when applied between May 22 and October 28.

Evaluating forest plantation establishment and management can utilize before-tax financial criteria (Gunter and Haney 1984, Klemperer 1996, Bullard and Straka 1998, Grebner and others 2003). Before-tax analysis may include property taxes and severance taxes as annual and single-sum costs in a discounted cash flow model, but it does not consider a landowner's marginal tax rate or capital gains (Bullard and Straka 1998).

## DATA

The kudzu control information applied in this study was obtained from both published and unpublished sources. Research by Ezell and Nelson (2006) is based on an ongoing study where they evaluated the impacts of alternative herbicide treatments on kudzu patches in MS and SC. Plots were sprayed and percent brown up and percent kudzu cover were calculated from ocular estimates four times after initial spray. Table 1 provides herbicide impact on kudzu cover for plots treated in MS.

In this study, for simulating the afforestation of a site with loblolly pine, we used PTAEDA 3.1 to project pine growth

to a fixed rotation age. Harvesting activities occurred as either thinning operations or final stand replacement cut. Rotation lengths for afforested sites to pine plantations were normalized to 30 years. Herbicide applications occurred in late summer of the first year. For pine sites, planting occurred the following spring. In addition, on older kudzu sites, re-application of herbicides by backpack sprayers occurred during the second summer.

Cost information used in this study was collected through personal communication with herbicide vendors and from the Forest Landowners Association. In this analysis, a 6 percent real discount rate was used. Average costs per acre for afforestation in MS in 2005 are reported in table 2.

Per acre values of these costs, for herbicide treatments, were calculated using container size, price, and adjustments for application rates. For older kudzu patches, percent kudzu coverage one year after initial treatment (table 1) was used to adjust the re-application cost when using a backpack sprayer to spot control resprouting (table 2).

The price data used to compute harvest values was taken from Timber Mart South. Mississippi Region 1 data was averaged for the four quarters of 2005. Averaging was performed for pine sawtimber and pine pulpwood. In addition, it was assumed that landowners would be able to lease their land for lease hunting purposes at an average of \$5.50 per acre per year (table 3).

## METHODS

This study compares three alternative management regimes for eradicating kudzu patches and afforestation of appropriate sites to pine plantations in Mississippi. Land Expectation Value (LEV) on a before-tax basis was used to evaluate the feasibility of these practices. Although the examples are hypothetical, scenarios reflect a realistic commercial design. Herbicides were dispersed by pumper truck. Relative age of kudzu was categorized as either old or young with tuber size being positively correlated with time.

## RESULTS

To compare the investment returns for controlling kudzu using alternative management regimes, LEV was calculated for each regime given the before-stated assumptions. Figure 1 illustrates the before-tax LEVs for alternative management regimes that control kudzu and afforest the site to a pine plantation.

The results in figure 1 clearly display differences in before-tax LEVs between regimes and kudzu patch age. In general, the results show that the LEV for treating older kudzu patches is lower than treating younger patches. The average LEV for the alternative regimes treating the older kudzu patches is \$494.18 per acre with a range of \$387.67 to \$622.75 per acre. The average LEV for the alternative regimes treating the younger kudzu patches is \$588.05 per acre with a range of \$532.19 to \$680.40 per acre. The results suggest that for controlling older or younger kudzu patches applying 4 ounces of Escort will provide the greatest financial return and biological control. In general, all three treatments will

**Table 1—Average percent kudzu cover by treatment and time of observation in Mississippi 2004**

Treatment (ounces per acre)	Time of Observation			
	June	July	August	September <sup>b</sup>
Escort (4)	3.3a <sup>a</sup>	8.3a	18.0a	23.3
Transline (21)	28.3b	37.3b	57.0b	76.7b
Tordon K (128)	3.0a	10.0a	16.7a	20.0a

<sup>a</sup> values in a column followed by same letter do not differ  $\alpha=0.05$ .

<sup>b</sup> increase in coverage due to vine growth—no new sprouts in any treatment area except with Transline application.

Source: Ezell and Nelson (2006).

**Table 2—Average cost per acre by activity for Mississippi in 2005<sup>a</sup>**

Activity	\$ per acre
Seedlings <sup>b</sup>	\$34.12
Hand planting	\$37.16
Land use tax <sup>c</sup>	\$5.00
Annual management fees	\$5.00
Burn	\$21.08
Escort XP (4 ounces)	\$66.40
Transline (21 ounces)	\$54.81
Tordon K (128 ounces)	\$172.80
Truck application	\$100.00
Backpack spraying	\$35.00

<sup>a</sup> Herbicide cost information obtained by personal communication with Kenneth Moss.

<sup>b</sup> Seedling price is \$0.05 per seedling and 726 seedlings planted per acre.

<sup>c</sup> Average per acre property tax for forestland in Mississippi is approximately \$5.

**Table 3—Price and revenue information for standing timber and fee hunting in Mississippi in 2005<sup>a</sup>**

Species	Prices
Pine sawtimber	\$434.2 per 1000 board-foot Doyle
Pine pulpwood	\$8.35 per cord
Hunting leases <sup>b</sup>	\$5.50 per acre per year

<sup>a</sup> Timber prices from TimberMart South.

<sup>b</sup> Dr. Stephen Grado, pers.comm. (2005).

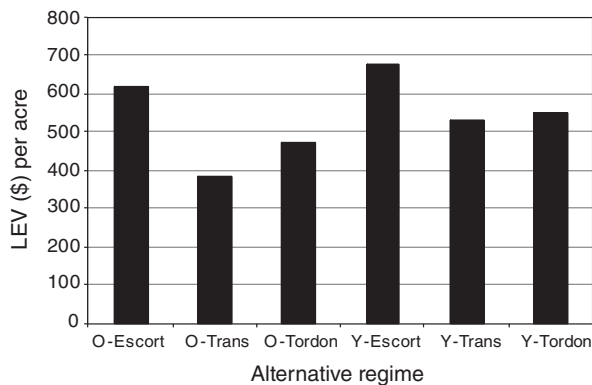


Figure 1—Before-Tax Land Expectation Values for alternative treatments by truck controlling old and young kudzu and establishing pine plantations.

lead to positive financial returns from controlling kudzu and afforesting appropriate sites to pine plantations.

## DISCUSSION

An important issue, when evaluating this study's results, is whether herbicides are physically available and the concentration of active ingredient per container. Since Ezell and Nelson (2006), which used 2004 field data, the United States Environmental Protection Agency and Dow Agrosciences LLC reached an agreement to reduce the approved rate of use of Tordon K on a per acre basis. This agreement was due to various environmental concerns that pertained to the active ingredient, picloram, being a very mobile molecule getting into the water table. This has been an issue in agricultural regions outside the Southern United States. The importance of this agreement indicates that the expected results for controlling kudzu patches using Tordon K will not be effective without repeated spraying which will increase costs and reduce investment returns for landowners.

Controlling kudzu with herbicides can be a costly alternative for private landowners. Fortunately, there are multiple federally funded cost-share programs that offer assistance to private landowners enabling them to combat the spread of non-native invasive plant species such as kudzu. One such program is the Environmental Quality Incentives Program (EQIP). EQIP is a well funded cost-share program sponsored by the Natural Resources Conservation Service that provides technical and financial assistance to landowners for conservation management on agricultural and forested lands.

## CONCLUSIONS

In summary, the goal of this study was to examine the monetary returns for controlling kudzu using alternative herbicide treatments. The analytical approach utilized before-tax LEV estimates to conduct a comparative analysis of different control and afforestation regimes. The results suggested that the most cost-effective way to control kudzu patches is to spray Escort XP by a ground dispersal unit. This application was appropriate for both young and old kudzu patches.

This research serves as a basis for conducting additional invasive species control work on both pine and hardwood sites. Further economic analysis research is necessary to address the federal and state incentive programs because the potential benefits to the individual landowner and society can be substantial. In addition, future work on invasive species in relation to state income taxes would be useful.

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