vantage of connected root suckers is their collectively greater size which can more effectively occupy and compete for a site. Vegetative reproduction for *Ailanthus* insures the continued existence of the genetic individual as well as low risk mortality for its offsprings. Moreover, the colonization of *Ailanthus* was not restricted to open habitats where it had to compete with other plant species (10). Instead, it was able to establish in restricted areas where other plants could not sustain growth. The *Ailanthus* root system seemed most suited to such habitats. A few flexible lateral roots and a large tap root supporting the growth of *Ailanthus* may explain the successful growth of *Ailanthus* in the edge habitats that dominate our urban landscape.

Significance to the Nursery Industry

Several aspects of *Ailanthus* growth seem to have implications for managing trees in the urban environment. In the past, allowance for natural groupings have been discouraged; instead, trees are grown in an environment unlike the forest ecosystems of their origin and in a manner that subdues natural tendencies for vegetative sprouting and root suckering. In view of *Ailanthus* preferred clump formation, a new approach might prove worthwhile. It would mean enlarging single street planting sites to where grouped plantings would be possible. *Ailanthus* is also capable of surviving in edge habitats because it has a few, long, flexible lateral roots. Other trees bound for planting in the urban environment may be selected for similar root properties or be placed in areas conducive to lateral root growth.

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Sod Marketing at the Consumer Level[1]

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Abstract

Demand and consumption relationships for sod at the consumer level of the market were estimated. The price of sod, lot size and property value had significant impact on sod purchases. Consumers were responsive to sod price changes with a 1% change in price resulting in a 1.83% change in quantity demanded, other factors being held constant at mean levels. An evaluation of data for purchasers and nonpurchasers of sod indicated that income, house age, interest in landscaping and occupation had significant impact on purchases. Income elasticities for households having an annual income in excess of $31,000 were found to be elastic; that is, these households respond to income increases with larger purchases of sod. The market participation (entry-exit) phenomenon was credited with at least 70% of the total market adjustment by purchasers. These relationships emphasize the need for careful examination of advertising and pricing efforts of sod producing and marketing firms and also the potential growth of the industry as incomes and the general standard of living increase.

Index words: marketing, turfgrass-sod, income and price elasticities, consumer level modeling

Introduction

Commercial turfgrass-sod, hereafter referred to as sod, has received much attention in recent years as an alternative use for the land resource. This interest is exemplified by acreage and income expansion experienced in Alabama. Acreage expanded from 202 ha (500 A) in 1968 to about 2206 ha (5,450 A) in 1983 (4). Gross farm income has also increased from about $4.2 million wholesale in 1979, excluding delivery and installation charges, to about $7.1 million wholesale in 1983. With the enhanced economic importance of the industry has come the need for a better understanding of markets for and the marketing of sod.

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Little is known about the marketing aspects of the commercial sod industry, especially beyond the producer level. This study aims to identify product familiarity and consumption relationships for sod at consumer level with emphasis given to identifying the impacts of factors which affect sod purchases. Special attention is given to the influence of sod price and buyer's income on sod purchases. Currently, information from such analyses does not exist in the literature. Since production and marketing aspects of Alabama's industry are reflective of the southern sod industry, we believe these results can be generalized to the region and possibly to other areas which are compatible in terms of the production system and markets.

Alabama's sod production system includes firms ranging in size from 2.02 to 332 ha (5 to 820 A), with an average operation having about 65 ha (160 A) (1). Producer experience in sod production ranges from 2 to 33 years with an average of 12 years. The largest concentration and the majority of producers are located near or within metropolitan areas (SMA's). Thus, producers are located near their major outlets, larger cities with much industrial and residential activity.

Bermudagrass (*Cynodon sp.*) is the most widely grown and marketed sod, comprising 48% of the acreage and 60% of gross farm revenue. The remaining acreage is about equally divided between zoysiagrass (*Zoysia sp.*) and centipedegrass [*Eremochloa ophiuroides*, (Munro) Hack.] at 27% and 23%, respectively. Revenues generated by zoysiagrass and centipedegrass account for 24% and 16% of the total, respectively. A small amount of St. Augustinegrass [*Stenotaphrum secundatum*, (Walt.) O. Kuntze] is also grown.

The majority of the sod produced in Alabama is marketed within the state. However, the relative proportion of in-state marketings declined slightly from 78% to 72% between 1979 and 1983. As indicated, sod sales are concentrated in the larger cities and surrounding areas. Out-of-state markets include the bordering states plus Arkansas. Georgia accounted for approximately 70% of the out-of-state total and the greater Atlanta market area accounted for a major portion of the Georgia component.

Major buyers and users of sod were divided into six categories: 1) landscape contractors, 2) homeowners, 3) garden centers, 4) building contractors, 5) golf courses, and 6) other growers. Landscape contractors are dominant in the market, accounting for 34% of the total sales while homeowners and garden centers are next in prominence with 22% of the total each. Building contractors account for 17% of the total.

Materials and Methods

Since primary markets for sod are in the larger economic centers which generally correspond to metropolitan areas, household surveys were conducted in selected areas of six cities in Alabama. A sample of 200 households was drawn for the six SMA's using telephone directories. Households included in the sample were randomly selected from rapidly growing middle-to-upper income areas as indicated by each city's planner. To supplement the purposive random sample and facilitate analysis of characteristics of sod purchasers, 35 additional households which had purchased sod within the past year were identified based on information provided by local landscape contractors and producers.

Household data regarding such factors as price (for those who purchased sod), income, house value, lot size, occupation, house age, and educational attainment of the head of household were collected from all identified households through telephone interviews. Also, product recognition (by the common name of the grass), price, and product form (rolls, blocks, sprigs) data were collected.

Two statistical procedures were used to analyze the data. First, Ordinary Least Squares (OLS) was used to estimate a demand relationship for those individuals who had purchased sod within the last three years. A supplemental list of sod purchasers was used to augment the list of purchasers from the general survey, with 74 observations available for this analysis. Emphasis was given to analyzing the impact of sod price on consumption and the relative sensitivity of purchases to changes in price.

Second, an alternative statistical procedure, Tobit analysis, was used to evaluate sod purchases by all households. Tobit analysis is useful in consumer behavior analyses in which the dependent variable (amount of sod purchased) has a limit, a lower limit of zero (no purchases) in this case. Due to the truncated distribution of the dependent variable, OLS would be inappropriate to use because the assumption of homoschedasticity would be violated (5). Thus, the Tobit model was employed. This technique was designed to address problems which frequently arise in studies of purchases of consumer durables (3).

The Tobit technique allows consideration of characteristics of both purchasers and nonpurchasers of sod, thus giving a better representation of the operation of market forces. Failure to account for the initial decision process involved in households' purchases can lead to bias in estimated parameters. Typically, some households would report no expenditures on sod due to particular reasons such as already established lawns, response to prices, or to general nonpreference for sod. Rather than alter or dispose of these observations containing no sod purchases, the Tobit model accounts for these data and thus more adequately portrays the full range of household behavior (2). The Tobit model was estimated using the data from the 200 surveyed households. Emphasis was given to determining the impact of income on sod purchases and the sensitivity of sod purchases to changes in income.

The Tobit model was estimated using a theoretical model which was implicitly specified as follows:

$$Y = f(I, E, O, V, Z, H, L)$$

where:

- Y = sold purchased by the household in square meters;
- I = household disposable income in dollars;
- E = education of the male head of household in a 0,1 discrete variable format for: 1) high school degree or equivalent, 2) some college, 3) college degree, or 4) professional degree;
- O = occupation of the male head of household in a 0,1 discrete variable format using the U.S. Bureau of Census (6) classification system for: 1) white collar (professionals, managers and administrators, and sales workers), 2) blue collar (craftsmen, operatives or service workers) and 3) others;
- V = value of property including the house and lot in dollars;
- Z = size of lot in square feet;
- H = age of house in years; and

L = degree of interest in lawn appearance and landscaping in a 0,1 discrete variable format with "interested" = 1.

Given economic theory and general knowledge of the sod market, hypotheses can be offered relative to the impacts of these variables. Each variable, except house age, was expected to have a positive impact on sod purchases. Since sod is believed to be a normal good, higher incomes would be expected to generate larger purchases. Also, sod purchases would be expected to increase with increases in the value of property (V), size of lot (Z), educational attainment (E) and for those who advance through the occupational strata (O) and exhibit a strong interest in lawn appearance and landscaping (L). House age (H) was expected to have a negative impact because homeowners tend to complete landscaping projects when the house is new or early in its life.

A similar model was estimated for the demand relationship using OLS with the exception that the price of sod (P) was added to the model. As with demand models, price and quantity demanded are expected to be negatively related. Other variables were hypothesized to have the same signs as specified in the Tobit model.

As is frequently the case with analyses of consumer behavior, variables tend to be correlated and the presence of this high degree of association tends to adversely affect the statistical analysis. Several variables evidenced sufficient interrelations to affect the statistical analysis. Thus, the estimated models differed from the theoretical models to the extent that efforts were made to lessen problems associated with a high level of correlation between independent variables. Curvilinear relationships (non-constant slopes) for the continuous variables were evaluated using the quadratic functional form in both models.

Results and Discussion

General Product Recognition. Consumer familiarity with the sod industry and its products was found to be good. Seventy-two percent of the responding households were familiar with the term "turfgrass-sod" when initially questioned. Further, a large portion (74%) of those who initially responded negatively toward knowledge of the term, responded affirmatively and were able to identify different sod types by common names after the term was defined by the interviewer.

Eighty-seven percent of all households were familiar with the different sods. Bermudagrass and zoysiagrass were the most recognized sod types with centipedegrass and St. Augustinegrass following, resp. Alternative product forms (sprigs, plugs, blocks, and rolls) were also relatively well recognized with 71% of the households being able to identify at least one product form. Almost half of the respondents were familiar with all four product forms.

The degree of familiarity was surprising, especially given the extent of advertising undertaken by producers. Average advertising outlay per dollar of sales was $.02 with the yellow pages and local newspapers being the primary media used. Word-of-mouth and past experience were the primary sources of sod related information noted by purchasers.

Statistical Analysis. The OLS model used to estimate the demand for sod explained 42% of the variation in sod purchases (Table 1). Lot size, sod price and property value had

Table 1. Turfgrass demand relationship, ordinary least squares parameter estimates, survey data for 74 households in Alabama, 1983.

Explanatory variables	Estimated coefficient	Standard error
Intercept	+5,119.62[z]	1,428.70
Sod price (P)	−980.95[z]	451.89
Size of lot (Z)	−0.04365[z]	0.0129
Age of house (H)	−24.56	16.48
Property (V)	−0.0473[z]	0.0178
Property squared (V^2)	+2.508D-07[z]	5.937D-08
Income (I)	+0.00652	0.02182
Interested in Landscaping (L)	−31.5723	686.973
Coefficient of Determination (R^2)	0.42	
Standard error of Estimate (S_e)	1,999.44	

[z]Significant at .05 critical level.

significant impacts on sod purchases; however, neither lot size nor property value had correct expected signs. Property value had a curvilinear impact (non-constant slope) on sod purchases. That is, purchases decline initially with increases in property value and eventually flatten and then increase. However, the curvilinear component (V^2) was quite small in absolute terms (.00000025). An increase by 0.0929 m^2 (1 ft^2) in lot size will result in a decrease of 0.04365 m^2 (.05 yd^2) in sod purchases. The price coefficient indicates that each dollar decrease in the price of a m^2 (yd^2) will result in an increase in sod purchases by 980.95 m^2 (1,170 yd^2). Or, alternatively, a one cent per m^2 (yd^2) decrease in price would increase sod consumption by 10 m^2 (12 yd^2) per household.

In order to gauge the sensitivity of quantity of sod demanded to price, the price elasticity of demand was estimated. A price elasticity of demand of 1.83 was calculated using mean values for the price and quantity of sod purchased. Thus, demand was elastic which implies that quantity demanded by consumers is highly responsive to price. For a 1% change in the price of sod, quantity demanded would change by 1.83%.

For the Tobit model, degree of interest in landscaping (L), occupational status (O), house age (H), and income (I) were significant (Table 2). All significant variables except white collar occupation and house age had correct expected signs. Interest in landscaping, occupation and house age had the strongest impacts on sod consumption. House age had a curvilinear impact (non-constant slope) indicating that sod purchases are not constant throughout the life of a house with decreased purchases initially and increased purchases as the house ages, Figure 1. For households which were interested in lawn appearance, the estimated coefficient indicated that these households would purchase 423 m^2 (530 yd^2) more sod than those showing little interest in lawn appearance and landscaping. Estimated coefficients for white collar and other occupation categories showed that these households would tend to buy 511 and 432 m^2 (611 and 517 yd^2) less sod than those in the blue collar grouping, other factors being held constant. The lower consumption by white collar households is somewhat unexpected. However, this could be justified by the fact that these households

Table 2. Turfgrass consumption relationship, tobit parameter estimates, survey data for 200 households, Alabama, 1983.

Independent Variable	Tobit estimates: Normalized Coefficient	Regression Coefficient	Adjusted Regression Coefficient
Intercept	− 0.64923 (0.43335)[z]	−2,242.7	−463.8
Lot size (Z)	3.345D-07 (3.7630-06)	0.00123	0.00025
Income (I)	1.47D-05[x] (7.70-06)	0.05098	0.01054
Property value (V)	4.3D-07 (9.20-06)	0.001503	0.000311
House age (H)	− 0.0522[y] (0.0198)	−180.25	−37.28
House age squared (H^2)	0.000819[y] (0.00038)	2.8191	0.58299
Interested (L)	0.61998[y] (0.19277)	2,141.66	422.898
White collar (01)	− 0.71545[y] (0.2331)	−2,471.43	−511.09
Other-retired (03)	− 0.60485[x] (0.30809)	−2,089.4	−432.09
R^2 between Y and $\hat{Y}$		.28	
Sum of Absolute Errors		108,813.96	
Log—Likelihood Function		−471.47	

[z]Standard errors are in parentheses.
[y]Significant at the .05 critical level.
[x]Significant at the .10 critical level.

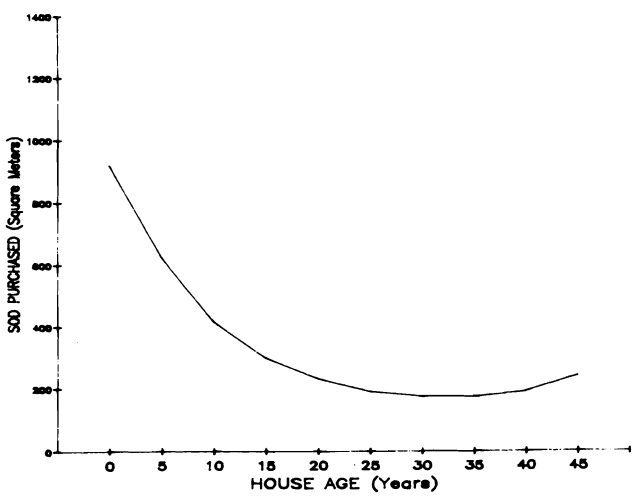

Fig. 1. Relationship of sod purchases and house age, other factors held constant at mean levels, Alabama, 1983.

had their landscaping done as a part of the house purchase or because they used custom landscaping.

Sod purchased showed a positive response to income (Figure 2). Of particular importance in this model is the sensitivity of sod purchases to changes in income. Table 3 provides income elasticity estimates which were derived from the Tobit model based on a 1% change at the sample means. The last three columns show, respectively, the estimated income elasticity, the market participation component (entry in and exit from the market) and the quantity response component (adjustments in purchases by those already in the market).

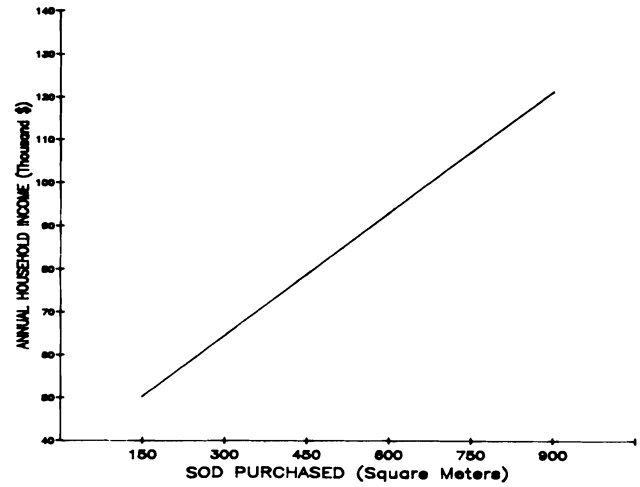

Fig. 2. Relationship of sod purchases and annual household income, other factors held constant at mean levels, Alabama, 1983.

Table 3. Income elasticities for varying levels of income, based on survey data, Alabama, 1983.

Income level	Total response	Market participation response	Quantity response
	percent		
$\bar{I} - 2\sigma$ ($18,996)	0.67	0.56	.11
$\bar{I} - 1\sigma$ ($31,890)	1.08	0.86	.22
$\bar{I}$ ($44,784)	1.40	1.08	.32
$\bar{I} + 1\sigma$ ($57,678)	1.65	1.22	.43
$\bar{I} + 2\sigma$ ($70,572)	1.83	1.30	.53

At an income level two standard deviations above the mean income ($I+2\sigma$ or $70,572), a 1% change in income would alter quantity purchased by an estimated 1.83%; i.e., 1.30% due to entry or exit of households into the market (new consumers entering the market) and 0.53% due to adjustments in consumption by households already in the market (past purchasers buying more sod). Similar inferences can be offered at other specified income levels.Given these estimates, income elasticity is elastic above an income of about $31,000; that is, sod consumption is responsive to changes in income above this level. These estimates hold important implications for sod growers and handlers as incomes and the standard of living increase. Also, they reflect the importance of higher income areas as prime sod markets for producers and marketing firms.

Significance to the Nursery Industry

Consumers were found to be quite familiar with the sod industry, its products, and alternative product forms. Such familiarity facilitates market exploitation and development. Producers and marketers must strive to maintain and/or enhance this knowledge base through advertising and consumer education.

Factors affecting sod markets were analyzed from two perspectives: an analysis of a sample of households which had recently purchased sod; and, an analysis of a sample of households which included both purchasers and nonpurchasers of sod. Lot size, sod price, and property value had

significant impacts in the first analysis while income, degree of interest in landscaping, house age, and occupational status of the head of household were significant in the latter analysis. These factors deserve careful attention in marketing plans of producers and marketers.

For each one percent reduction in price, quantity of sod demanded increased by 1.83 percent. Consumers are highly responsive to price changes. Thus, if costs are favorable, producers can stimulate sales and possibly enhance profits through price adjustments.

Increases in household income was found to have a positive impact on sod purchasers. Purchases were found to be responsive to changes in income beyond the $31,000 level. For changes in income at and beyond this level, 70% or more of the market adjustment was due to new consumers entering the market. The balance of the market adjustment resulted from former sod purchasers buying additional sod. These estimates provide useful information relative to targeting promotional activities and sales as well as insight into future opportunities for the industry as incomes and the general standard of living increase.

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Influence of Stratification and Light on Germination of Sourwood (*Oxydendrum arboreum* (L.) DC.)[1]

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Abstract

Comparison of stratified and nonstratified seed demonstrated that at 25° C (77° F), as duration of stratification increased from 0 to 60 days, germination percentage also increased. However, an opposite effect occurred for seed exposed to alternating temperatures of 30/20° C or 25/15° C (86/68° F or 77/59° F). There were no significant differences observed in the final germination percentage between seed stratified for 30 days and nonstratified seed. Stratification hastened germination and decreased the light required for germination.

Index words: sorrel tree, propagation, seed, moist-chilling

Introduction

Viable seed, which do not germinate under conditions normally regarded as favorable for germination, are considered to be dormant (13). Three southern species of *Kalmia* (*K. hirsuta* Walt., *K. latifolia* L. and *K. cuneata* Michx.) exhibit seed dormancy. Three species of *Kalmia* whose native ranges are further north (*K. angustifolia* L., *K. polifolia* Wangenh., *K. polifolia microphylla* (Hook.)Rehd., var.) exhibit no seed dormancy (9). This suggests that seed dormancy is a means for preventing fall germination in southern latitudes, where seed are subjected to warm temperatures after their release from the capsule. If these seed were able to germinate, the tender seedlings would be susceptible to winter kill. The adaptation is not necessary for many northern species. By the time the seed disperse, conditions are not favorable for germination (9).

In many plant species, dormancy may be satisfied by cold-moist stratification (6, 8, 13, 15). *K. latifolia* L. seed are partially dormant. Moist-cold stratification for eight weeks will cause an increase in germination from 40–50% to 60–75% (9). Olson and Barnes (14) and Fordham (7) reported that sourwood seed do not have an inhibiting dormancy. Stratification has been found to substitute for a light requirement in some species that do not require stratification for germination (2, 4). The optimum temperature for germination may change as a result of stratification (1, 12) or light and temperature effects may be eliminated entirely (16). Stratification has also been found to decrease the germination interval in Fraser fir (*Abies fraseri* (Pursh) Poir.) (1) and *K. latifolia* L. (9). The following experiments were designed to study the effects of stratification on the light and temperature requirements of sourwood (*Oxydendron arboreum* (L.) DC.) seed for germination.

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