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DISTRIBUTION AND EFFECT OF GRAPE MATURITY ON ORGANIC ACID AND SOLUBLE CARBOHYDRATE CONTENT OF RED MUSCADINE GRAPES

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Abstract. **The nature and content of muscadine grape organic acids and soluble carbohydrates, their distribution in grapes and changes in their relative concentrations with grape maturity were determined by HPLC. Distribution of the organic acids and carbohydrates was uneven within the berries. Acids were concentrated around the skin, while sugar content was highest in the juice. Unlike previous reports involving non-muscadine varieties, the major acids in the muscadines were succinic acid, tartaric acid and malonic acid. Succinic acid was the most abundant acid immediately after fruitset, but its concentration dropped sharply as the fruits matured. Tartaric acid was the most prominent acid from verasion until the fruits were fully mature. Malonic acid content increased gradually until verasion, after which it decreased as the fruits ripened. Malic acid was only present in minute quantities, a factor that might be responsible for the lack of malo-lactic fermentation in muscadine wines. Glucose and fructose are the two soluble carbohydrates present in the cultivars. The glucose to fructose ratio (2.0 at fruit-set) decreased as the fruits matured. The physiological differences between muscadine and non-muscadine grapes are expected to influence the properties of their processed products.**

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STRUCTURAL CHANGES IN FLORIDA'S VITICULTURAL INDUSTRY: ANALYSIS AND PROJECTIONS

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Abstract. **The viticultural industry in Florida has undergone significant structural transformation in number of farms growing grapes, acreage and production of grapes during the last decade. Economic conditions and marketing factors have contributed much to restructuring in the industry. Projections using the Trend Extrapolation, Moving Average and Exponential Smoothing techniques showed that 319 farms will be growing about 848 acres of grapes in Florida by 1997. Grape acreage will continue to grow at a modest rate as more growers are attracted to the industry. Annual production is also expected to increase and exceed 2 million pounds by 1997.**

Florida's viticultural industry has undergone significant change during the last decade. These changes have caused industry analysts to speculate on the future of Florida's viticultural industry. Several views have bee expressed, but, they often lacked an empirical and statistical basis. The vineyard and winery survey conducted by the Florida Agricultural Statistics Service in 1989 provides information on the current status of the industry in Florida and the changes that have occurred during the last decade. Identifying and quantifying these changes will provide useful information and help in projecting future changes.

Objectives

The objectives of this study were 1) to analyze the changes in number of farms growing grapes, the acreage of grapes grown, and the production of grapes in Florida between 1978 and 1990, and 2) to project the future structural characteristics for the industry to the year 1997 by using the Moving Average, Exponential Smoothing and Trend Extrapolation techniques.

Sources of Data

Data for the study were obtained from the Census of Agriculture 1978, 1982, 1987 (10) and Florida Vineyard and Winery Report 1989 (4). The census data were used in the analysis and projection of structural characteristics.

Methodology

The analysis of structural change was conducted on a regional basis by dividing the state of Florida into four regions: Northern, Western, Central, and Southern as classified by the Florida Agricultural Statistics Service (Figure 1). Counties that had little grape production and could not be identified in any of the regions for various technical reasons were classified as "All Others".

The sparse census of agriculture data between 1978 and 1989 greatly restrict the statistical techniques that could be used to analyze structural changes. These changes are affected by complex political, economic, and social factors which present a major challenge to economists when forecasting them. Econometric techniques that are often used require a large number of observations. Furthermore, the constraint of limited data could also lead to highly unreliable projections if only one forecasting technique is depended upon. These limitations, and the desire to increase the reliability of the projections make a composite forecast preferable to any one technique. A composite forecast takes into account both the linear and nonlinear effects.

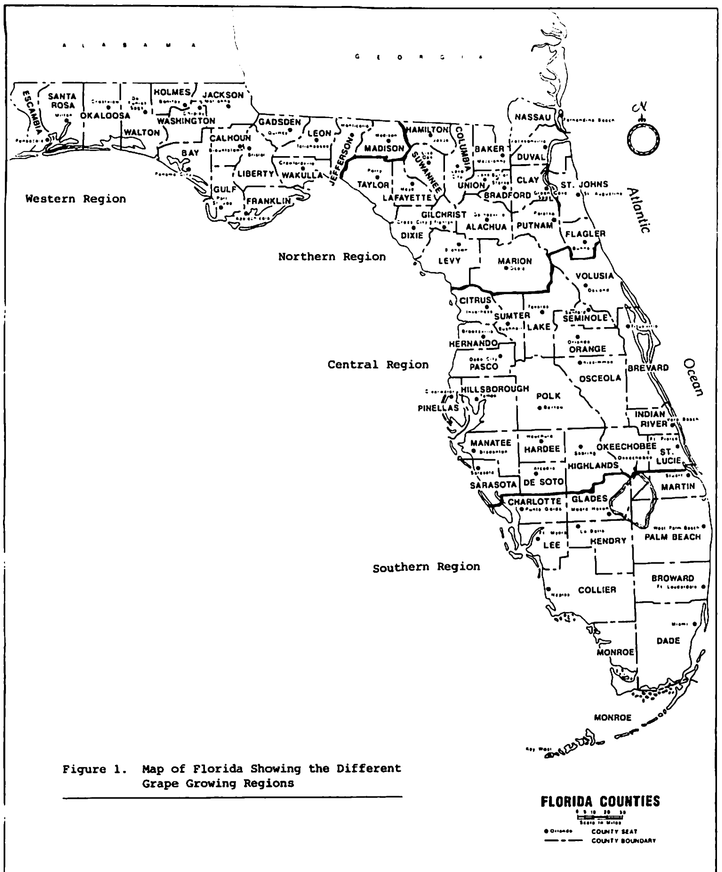

Figure 1. Map of Florida Showing the Different Grape Growing Regions

Trend Extrapolation. The trend extrapolation technique involves estimation of a linear trend equation using Ordinary Least Squares (OLS). The trend function assumes a linear relationship between structural change and time. Statistically, the relationship can be expressed as $Yt = a + b(Tt)$, where Yt is the projected structural characteristic in period t and Tt is the time in period $t = 1, 2, 3, ..., n$. The letters a and b in the trend equation represent structural parameters.

Moving Average. Under the constraint of limited observations and uncertainty of a linear relationship between the variables, the moving average is often used to make trend projections. The moving average technique is useful in projecting the trend when a nonlinear relationship is anticipated. A two year moving average was used in the projections.

Exponential Smoothing. The exponential smoothing technique uses a smoothed value of the time series in one time period to forecast the value in the next time period. The advantage of using the exponential smoothing technique is that it requires little historical data to make fairly accurate projections. The basic model used in the forecast is:

$$F_{t+1} = Yt + (1-\alpha)\ Ft$$

Where $Ft+1$ = forecast in period $t+1$
Yt = actual value in period t,
Ft = forecast in period t and
α = smoothing constant ($0 \leq \alpha \leq 1$)

The reliability and accuracy of the predictions depends on selection of the proper smoothing constant (α). The choice of $\alpha = 0.5$ was based on the mean square errors (MSE) of the forecasts. Using α with a larger value provides for more rapid adjustment to changing conditions (1, p. 640).

Analysis of Structural Change

The projections of structural changes were based on composite forecasts derived from three forecasting techniques (Table 3). Structural changes were forecast independently for each region. Forecasts for the state were based on cumulative changes from the different regions (Table 1). Historical trend was used to verify the projected trend. In some cases the projected trend showed an inverse relationship to the historical trend.

Number of Farms with Grapes. Grape growing in Florida is concentrated in three major regions: North, Central and West (Figure 1). The South is not considered a grape growing region although small quantities of grapes are being grown in some of the counties. The total number of farms growing grapes in Florida declined from 430 in 1978 to 298 in 1987 (30.7%) and to 167 (43.9) in 1989. The decline in farm numbers was observed in all except the Central region which increased by 28 farms (47.5%) between 1978 and 1987 and 23 farms (34.8%) between 1987 and 1989.

The total number of farms growing grapes in the state is projected to increase from 167 in 1989 to 319 in 1997

Table 1. Projections of Structural Characteristics of Florida's Viticultural Industry, by Region, 1978-1997.

	Region				
	North	West	Central	All Other	Florida
Number of farms	110	96	59	165	430
Year					
1978	110	96	59	165	430
1982	118	79	73	33	306
1987	105	74	87	32	298
1989	51	44	66	6	167
1992*	109	73	89	50	321
1997*	107	69	93	50	319
% Chg. 78-89	−53.64	−54.17	11.86	−96.36	−61.16
% Chg. 87-89	−51.43	−40.54	−24.14	−81.25	−43.96
% Chg. 89-97*	109.80	56.82	40.91	733.33	91.02
Acreage of grapes					
Year					
1978	172	121	79	49	421
1982	190	172	114	168	644
1987	159	325	193	97	784
1989	160	246	153	21	580
1992*	168	298	180	129	775
1997*	165	345	206	132	848
% Chg. 78-89	−6.98	103.31	93.67	51.14	37.77
% Chg. 87-89	0.63	−24.31	−20.73	−78.35	−26.02
% Chg. 89-97*	3.13	40.24	34.64	528.57	46.21
Production of grapes (lb)					
Year					
1978	151,526	136,384	58,616	34,252	380,778
1982	172,669	175,220	10,715	1,004,013	1,362,617
1987	92,008	463,250	290,584	684,500	1,530,342
1989	–	–	–	–	1,935,000
1992*	113,000	404,000	222,000	417,000	1,156,000
1997*	96,000	483,000	284,000	972,000	1,835,000
% Chg. 78-87	−39.28	239.67	395.74	99.84	301.90
% Chg. 87-97*	4.34	4.26	−2.27	30.02	19.91
% Chg. 89-97*					−5.17

* Forecast

(91.02%), but only marginally (7.05%) when compared to 1987. All regions were projected to increase in farms with grapes, including counties that currently produce few grapes.

Grape Acreage. Grape acreage in Florida increased by 363 acres (86.2%) from 421 to 784 acres between 1978 and 1987, but declined by 204 acres (26.0%) two years later. A similar historical pattern was observed for the regions.

Projections show increases in grape acreage for Florida of 268 acres (46.21%) between 1989 and 1997. Most of the increase will come from the West (40.24%) and Central (34.64%) regions, although nontraditional grape growing counties show the greatest percentage increase.

Grape Production. Grape production in Florida increased from 380,778 pounds in 1978 to 1,530,342 pounds (301.9%) in 1987 and to 1,935,000 pounds (26.4%) in 1989. Except for the Northern region, grape production in all regions increased substantially between 1978 and 1987, ranging from 99.8% to 395.7%.

Although Florida's grape production is projected to decline by 50 tons (5.2%) between 1989 and 1997, this decline is unlikely to occur because acreage and number of farms with grapes are projected to increase by 46.2% and 91.0%, respectively. Grape production could reach two million pounds by 1997.

Grape Acreage Per Farm. The average acreage of grapes per farm was derived by dividing total acreage of grapes by total number of farms with grapes. Average acreage per farm in Florida is small but is increasing in all regions. Average acreage per farm was 0.98 acre in 1978 and grew by 254% to reach 3.47 acres in 1989. Projected acreage per farm shows a decline between 1989 and 1997.

Production Per Farm. Grape production per farm was derived by dividing total production by total number of farms with grapes. The result showed that the average production per farm in Florida increased 480.2% from 885 pounds in 1978 to 5,135 pounds in 1987 and by 125.6% to 11,586 pounds in 1989 (Table 2). All regions, except the North, recorded increased per farm production between 1978 and 1987. The state projection shows a 50.4% decline in average production per farm between 1989 and 1997.

Production Per Acre. Production per acre was derived by dividing total production by total acreage. Grape production per acre increased in all except the Northern region between 1978 and 1987 (Table 2), with the greatest increase (236.2%) in the Central region.

Projections for the state show that grape production per acre will continue to increase, but per acre production in the Western and Central regions is projected to decline by 1.8% and 58.7%, respectively.

Concluding Remarks

Grape acreage, the number of grape growers, and grape production in Florida are expected to increase. A large influx of new grape growers is not expected because of the high per acre capital requirement (3, 5, 7).

Given the high cost of capital and other farm inputs, it is important that resources used for grape growing should provide adequate returns to the investment for the industry to expand. Yield data from Mortensen and Hayslip (8), Nesbit and Carroll (9); AREC (2), Lane (6) showed that per acre production should be much higher than reported. As more vines reach bearing age and growers gain experi-

Table 2. Projections of Acreage and Production Per Farm of Florida's Viticultural Industry, by Region, 1978-1997.

	Region				
	North	West	Central	All Other	Florida
Acres per farm					
Year					
1978	1.56	1.26	1.34	0.30	0.98
1982	1.59	2.18	1.56	5.09	2.10
1987	1.51	4.39	2.22	3.03	2.63
1989	3.14	5.59	2.32	3.50	3.47
1992*	1.54	4.28	2.01	2.58	2.41
1997*	1.54	5.00	2.22	2.64	2.66
% Chg. 78-87	−3.20	248.41	65.67	910.00	168.37
% Chg. 87-97*	1.89	13.90	0	−12.87	1.14
% Chg. 89-97*	−50.96	−10.55	−4.31	−24.57	−23.34
Prod. per farm					
Year					
1978	1,377.51	1,420.67	993.49	207.59	885.53
1987	876.27	6,260.14	3,340.05	2,139.06	5,135.38
1989	–	–	–	–	11,586.83
1992*	1,037.00	5,534.00	2,494.00	8,340.00	3,601.00
1997*	897.00	7,000.00	3,054.00	19,400.00	5,752.00
% Chg. 78-87	−36.39	340.65	236.19	930.43	479.92
% Chg. 87-97*	2.37	11.82	8.56	808.84	11.98
% Chg. 89-97*					−50.35
Prod. per acre (lb)					
Year					
1978	880.97	1,127.14	993.49	699.02	904.46
1987	578.67	1,425.38	3,340.05	705.67	1,951.97
1989	–	–	–	–	3,336.21
1992*	673.00	1,356.00	1,233.00	3,233.00	1,492.00
1997*	581.00	1,400.00	1,379.00	7,364.00	2,164.00
% Chg. 78-87	−34.31	26.46	236.19	0.95	115.82
% Chg. 87-97*	0.52	−1.75	−58.71	943.55	10.86
% Chg. 89-97*					−35.14

* Forecast

Table 3. Projected Structural Characteristics of Florida's Viticultural Industry, by Region and Forecasting Technique.

	Forecasting Technique							
	1992				1997			
	MA	ES	TE	COMP	MA	ES	TE	COMP
Number of farms								
Northern Region	111	110	106	109	108	110	103	108
Western Region	77	81	61	73	76	81	50	69
Central Region	88	77	101	89	88	77	115	93
All other	33	66	–	50	33	66	–	50
Florida	309	334	268	321	305	334	268	319
Acreage								
Northern Region	174	170	160	168	167	173	154	165
Western Region	249	235	410	298	287	235	512	345
Central Region	154	145	242	180	174	145	299	206
All Other	133	103	152	129	115	103	177	132
Florida	710	653	964	775	743	656	1142	848
Production (M lb)								
Northern Reg.	132	127	79	113	112	127	49	96
Western Reg.	319	309	585	404	391	309	748	483
Central Reg.	151	163	351	222	163	468	284	
All other	536	294	420	417	764	602	1550	972
Florida	1,138	893	1,435	1,156	1,488	1,202	2,815	1,835

MA = Moving Average
ES = Exponential Smoothing ($\alpha = 0.5$)
TE = Trend Extrapolation
COMP = Composite = {(MA + ES + TE)/3}

ence in vineyard management, production per farm and production per acre should increase significantly, instead of declining between 1989 and 1997 as statistically projected.

The projected trend suggests that hobby farmers may increase over time since acreage and production from non-traditional grape growing areas are projected to increase substantially in the state within the next ten years.

Literature Cited

1. Anderson, D., D. Sweeney and T. Williams. 1988. An Introduction to Management Science—Quantitative Approaches to Decision Making. 5th ed., New York, West Publishing Co.
2. AREC, IFAS, University of Florida, Leesburg. 1985. Research Report (LBG 85-2).
3. Bateman, L. 1989. "Establishing a Muscadine Vineyard: A Possible Alternative Enterprise." Proc. Vit. Sc. Symp., Florida A&M University.
4. Florida Agricultural Statistics Service. 1990. Florida Vineyard and Winery Report 1989. Orlando, Florida.
5. Hewitt, T. 1988. "Enterprise Cost Analysis for Muscadine Grapes." Commercial Production, Processing and Marketing of Muscadine Fruit Juice and Deseeded Canned Fruit. Fla. Dept. Agr. Con. Ser., Tallahassee, Florida.
6. Lane, R. P. 1980. 'Triumph' Muscadine Grape. HortScience 15(3):322.
7. Leong, S. 1988. Financial Analysis of Investment Requirements and Profitability Analysis of Muscadine Production in Florida. Proc. Fla. State Hort. Soc., 101:264-268.
8. Mortensen, John and N. C. Hayslip. 1977. 'Welder' Muscadine Grape. HortScience 12(3):267-268.
9. Nesbit, W. B. and D. E. Carroll, Jr. 1982. 'Regale' Muscadine Grape. HortScience 17(2):276-278.
10. U.S.D.A. 1978, 1982, 1987. Census of Agriculture. U.S. Govt. Printing Office, Washington, D.C.

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EVALUATION OF BUNCH GRAPE ROOTSTOCKS AND MUSCADINE VARIETIES FOR RESISTANCE TO GRAPE ROOT BORER

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Abstract. **Hybrid bunch grape (*Euvitis* spp.) rootstocks were evaluated at Leesburg for resistance to grape root borer, *Vitacea polistiformis* (Harris), by infesting container-grown plants with eggs and by destructively sampling mature vines. Muscadine (*Vitis rotundifolia* Michx.) varieties were also evaluated for grape root borer damage. While no rootstock or variety completely escaped feeding damage, some sustained far less damage than others.**

In tests using container-grown plants, four of 14 rootstocks had significantly less borer damage than 'Tampa', including FL 13C-12 which also tended to sustain less damage in the vineyard. FL 13C-12 is noted for its resistance to Pierce's disease and ability to promote vigor and yield when grown in nematode-infested soils in Florida. Muscadine varieties 'Southland' and 'Regale' were significantly less damaged than 'Welder' and 'Hunt' after 10 years of growth at Leesburg. In general, perhaps due to differences in root depth, muscadine varieties sustained more borer damage than rootstocks of Florida hybrid bunch grapes.

The grape root borer, *Vitacea polistiformis* (Harris), long a serious pest of both bunch and muscadine grapes in the Southeast, now threatens Florida vineyards (1). Because the larvae feed below ground in roots, they are protected from many mortality factors. Insecticides applied to the soil surface do not penetrate deeply enough to kill most larvae (2,3), although in Florida, the only available chemical insecticide, chlorpyrifos, has been somewhat effective (W. E. Colson, personal communication). Fungi (5, 7, 11) and nematodes (7, 13) attack grape root borer in the soil but have not been successfully used as control agents. Mounding of soil underneath vines to prevent emergence of adults (10) has been used in some areas but is probably not of much use in Florida where grape root borer emerges over a period of five months in central and south Florida (S.E.W., unpublished).

Plant resistance to grape root borer could be a long term solution to its control. Differences in varietal susceptibility were first examined by Adlerz and Hopkins (1) by counting pupal skins around the bases of vines in established vineyards. This research was initiated to evaluate possible antibiosis to grape root borer in rootstocks derived in part from wild Florida bunch grapes and to assess differences in susceptibility to attack among both muscadine varieties and bunch grape rootstocks in the vineyard by comparing damage to roots.

Materials and Methods

To evaluate long term effects of grape root borer, plantings of muscadine varieties and bunch grape rootstocks that were being removed from the vineyard at CFREC-Leesburg were examined for damage by grape root borer. 'T' Block, removed from the vineyard in 1986 when vines were 12 years old, was a randomized complete block design with six blocks, with a single vine of each of 30 muscadine varieties in each block (8). Roots were cut with a spade at a radius of 2.5 ft from the trunk and then pulled out by tractor. All roots >0.25 inches in diameter were observed for damage. Total number of roots and number of roots with feeding damage characteristic of grape root borer were recorded.

Eleven varieties of muscadine (six vines each) from a planting in Monticello, Florida, that had been used to compare different training and pruning systems (4), were evaluated for damage by counting the number of roots and total number of feeding tunnels per vine. Vines were

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