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Sustainability Assessment of Fruit and Nut Crops in North Florida and North Central Florida[1]

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Introduction

This article summarizes the degree of adaptation of deciduous fruit and nut species in Florida and identifies cultivars that are recommended for trial in various locations in Florida.

Agricultural sustainability can be defined by models incorporating agricultural inputs and outputs. Agricultural inputs encompass pesticides, irrigation, fertilizer, tree training and pruning, fruit thinning, and farm equipment and machinery. Agricultural outputs include yield, fruit quality, gross and net profit. Any assessment of sustainability will also take into consideration the amount of labor required for successful culture of a given commodity and positive or negative impacts on the natural environment.

Deciduous fruit industries in Florida have changed during the last several decades. The prominence of a given commodity is determined by a multitude of climatic, edaphic, cultural and economic factors. The subtropical climate of Florida is suitable for the culture of numerous fruit and nut trees. However, some species can only be grown in Florida with the application of numerous agricultural inputs (i.e. fertilizer, pesticide, water, etc.). Certain species/cultivars can be grown successfully in Florida only with the investment of substantial inputs (marginally adapted) while other species/cultivars can be grown with a minimum of inputs (adapted). Some species/cultivars require such an extensive quantity of inputs so as to preclude successful culture (non-adapted) in Florida. There is not always a good correlation between profitability and sustainability. Some of the more difficult crops to grow in Florida (southern highbush blueberries, for example) can be extremely profitable under the right circumstances. By contrast, muscadine grapes are very sustainable, but offer relatively low profitability and market potential.

Before discussing the adaptability of species and cultivars, one point must be emphasized—the need for proper site selection. Almost without exception, the performance of fruit and nut trees is best in full sunlight and in well drained soils. In addition, because many species sustain frost injury in the late winter or early spring, avoid planting fruit crops in low-lying locations.

The adaptability of a given species/commodity is region-specific. A brief assessment of the suitability of adapted and marginally adapted fruit and nut species will follow (see Table 1). Table 2 summarizes impediments to successful culture of nonadapted species in north Florida and in the northernmost portions of central Florida.

In this publication, north Florida is defined as the region of the state north of Perry, which is near the Gulf Coast, north of Lake City, and north of Jacksonville, which is near

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the Atlantic Coast. North central Florida is defined as the region south of north Florida, but north of Cedar Key, which is on the Gulf Coast, and north of Ocala, which is in central Florida, and north of St Augustine, which is on the Atlantic Coast. Central Florida is a region south of the north central zone and north of Interstate 4, which runs through Orlando. Lastly, south central Florida is the area of the state around Sebring and extending northward to Interstate 4.

Chilling Temperatures for Decidious Crops in Florida

Figure 1 describes the different regions in Florida based on the average January temperatures. Relatively few deciduous crops are well adapted in the region of Florida that is roughly south of Tarpon Springs on the Gulf Coast and south of Daytona Beach on the Atlantic Coast. In the region of the state south of these cities, annual chilling temperatures are usually inadequate for deciduous crops. As a result, these crops may not have normal leaf and fruit development in the spring.

Most of this publication is, therefore, devoted to the regions of the state that, in Figure 1, are colored blue or purple. In these areas of Florida, deciduous fruit trees are likely to have at least 300 chilling units. (See Figure 2.) Chilling units are estimated as the accumulation of hours at an air temperature of 45°F or less during the dormant season. The further north one proceeds in Florida, the greater the available selection of deciduous fruit species/cultivars.

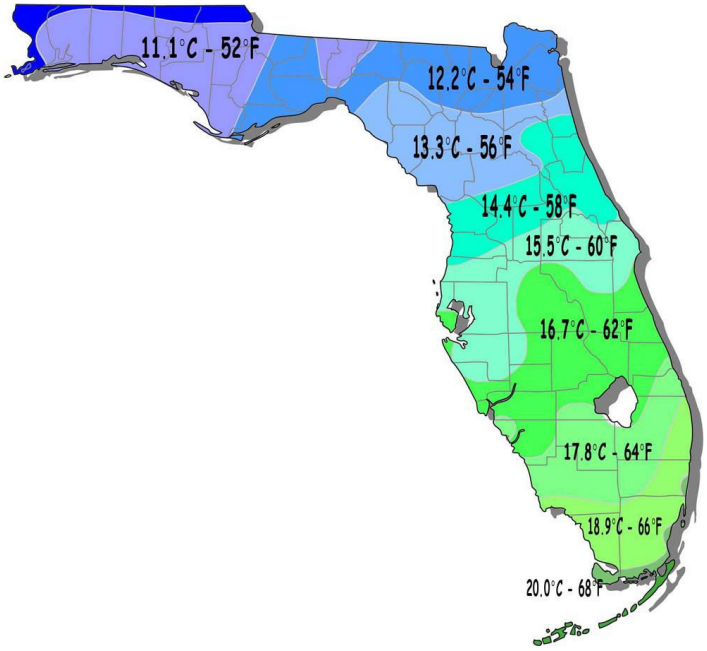

Figure 1. Average January Temperatures in Florida.

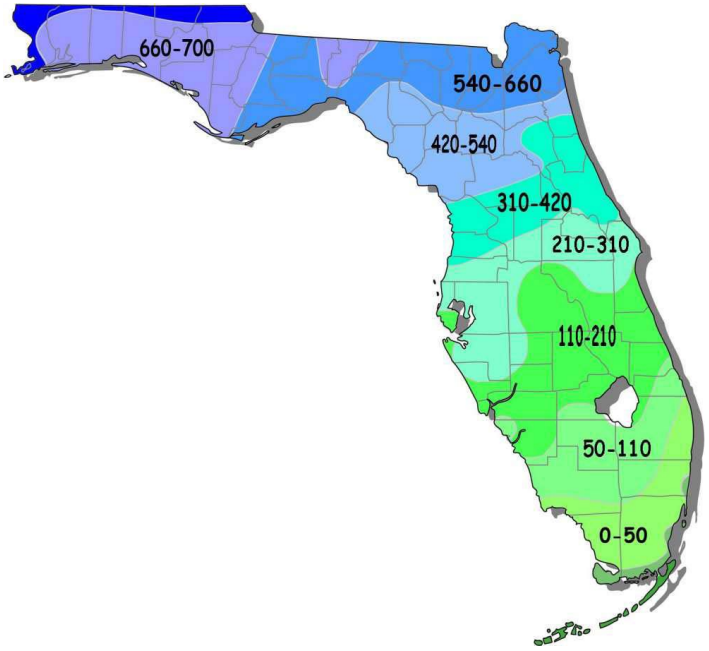

Figure 2. Estimated Chill Unit Accumulation for Florida.

Pecan

Pecan trees [*Carya illinoensis* (Wangenh) C. Koch] can be grown without a great deal of care, but consistently high yields are not likely without a rigorous pesticide spray program, irrigation, and fertilization (Andersen 1992b,c, 1995b, 1996, 1999, 2011; Andersen and Crocker 2012).

Limitations to successful pecan culture in the Southeast include the following:

1. A lack of new cultivars of high quality with resistance to pecan scab, *Cladosporium caryigenum,* (Ellis and Langl), (Gottwald) (Andersen and Crocker 2004, Bertrand 2000);

2. A long period before a return on investment can be realized (i.e. precocity = 5 - 12 years);

3. A retraction of an Internal Revenue Service provision allowing for depreciation of orchards during non-bearing years (which can last 5 - 10 years);

4. A lack of a suitable method of tree-size control; and

5. High and low yields in alternate years (i.e., alternate bearing).

The acreage of pecan orchards in Florida has declined during the last 20 years, although this acreage still exceeds that of all other remaining deciduous fruit in Florida combined. Recently, there is some economic incentive for

the expansion of pecan-orchard acreage in Florida. Since 2008, the worldwide demand for pecans has increased dramatically, mainly because of the emergence of China and other countries as major consumers. Much of the current acreage in Florida is not well maintained.

However, great advances have occurred in the biological control of insect pests by the use of exotic ladybug beetles to control aphids, use of leguminous cover crops for maintaining populations of natural enemies, and the Tedder's Trap for monitoring pecan weevils. For more information consult Mizell (2007a).

The application of pesticides usually precludes the opportunity for grazing in pecan orchards since most of these materials are not approved or registered for this purpose.

Pecans are assigned a moderate sustainability rating of 5 because a spray program for insect and disease pests is required during most years (Table 1).

The best pecan cultivars for homeowners in north Florida are the following: 'Cape Fear' (Storey 1977, Young et al. 1973); 'Elliott' (Conner and Sparks 2007); 'Curtis' (Taylor 1907); 'Stuart' (Thompson 1988); 'Sumner' (Leidner 1982); and 'Moreland' (O'Barr et al. 1990). Details concerning pecan cultivars are presented elsewhere (Andersen 1992a, 1995b, 1996, 1999, 2011, Andersen and Crocker 2012, Sparks 1992a,b). A new pecan cultivar trial consisting of 'Amling', 'Caddo', 'Lakota', 'Gafford', 'Apalachee', 'Creek', 'Excel', 'Cape Fear', 'Desirable', 'Curtis', 'Forkert', 'Gloria Grande', 'Elliot', 'Pawnee', 'Moreland', 'Melrose', 'Oconee', 'Sumner', 'Stuart', 'Kanza', and 'Kiowa' has been initiated at the NFREC-Quincy. The reader is referred to Andersen (2011) for a description of pecan cultivars. Several different cultivars should be planted together to ensure cross-pollination.

In Florida, pecan production is associated with a January minimum temperature no higher than 58°F or at least 300 chilling units.

Peach and Nectarine

The culture of peach [*Prunus persica* (L.) Batsch] and nectarine (a glabrous peach) trees requires attention to detail.

Peaches and nectarines can be categorized based on melting and non-melting flesh fruit types. Because melting-flesh type peaches and nectarines tend to incur bruising during handling, those destined for commercial markets are often picked before the optimum time and soften during placement on the grocery shelf. Non-melting peaches may be picked and shipped at physiological maturity since the flesh is firm and resists bruising. Peaches with non-melting flesh are somewhat apricot-like in texture.

Many low-chill peaches and nectarines have been developed by the University of Florida breeding program, which targets a market window from 15 April to 1 June. The optimum chilling requirement for cultivars adapted to north Florida is ca. 350 - 550 units, and for cultivars adapted to north central Florida it is ca. 225 - 375 units. Some peach cultivars that can be grown in south central Florida require only 75 - 150 chilling units.

The decline in peach/nectarine acreage over the last 20 years in Florida and in the southeastern United States has been mainly a function of a high incidence of late winter/early spring frosts. Extreme minimum temperatures during the winter have also been reported, on occasion, to kill flower buds of these trees. The decreased per capita consumption of peaches in the United States, in general, has also reduced demand, and competition from California growers has increased supply, particularly for mid- to late-ripening cultivars. However, new low-chill peach and nectarine cultivars released by the University of Florida breeding program offer great potential (Andersen et al., 1990a,b; Andersen and Sherman, 1990, 1994a,b, Sherman et al. 1988, 1995a,b, Williamson et al. 1995a,b,c, Ferguson et al. 2008).

Currently, the best available melting-flesh peaches for north Florida, in the order of ripening, are the following: 'Flordadawn' (Andersen and Sherman 1990); Flordaking' (Andrews et al. 1979); 'Flordacrest' (Sherman and Lyrene 1989); and 'Junegold' (Williamson et al., 1995b, Ferguson et al. 2002, 2008).

The best available nectarine for north Florida is 'Suncoast' (Andersen and Sherman 1995a, Ferguson et al. 2008). For north central Florida, the best available peach cultivars are 'Flordaprince' (Sherman et al. 1982), 'Flordaglo' (Sherman and Lyrene 1989b), 'TropicBeauty' (Rouse and Sherman 1989b) 'TropicSnow' (Rouse and Sherman 1989a, Williamson et al. 1995a,b,c), and 'Flordabest' (UF patented, Ferguson et al. 2008). 'Sunmist' (Sherman et al. 1995b; UF patented), 'Sunbest' (UF patented, Sherman and Lyrene 2002), and 'Sunraycer' (Sherman et al. 1995a) are the best available nectarines for north central Florida (Ferguson et al. 2008, Sherman et al. 1988, 1995a,b, 1988, Williamson et al. 1995b). For the central Florida and south central Florida region, 'Flordaprince' and 'TropicSnow' can be tried

in dooryard situations (Ferguson et al. 2008, Williamson et al. 1995a,b,c). 'Tropic Beauty' has performed well in commercial situations and is a standard low-chill cultivar worldwide (Rouse and Sherman 1986b).

Since 1997, non-melting flesh cultivars have been released from the University of Florida. These cultivars are patented and should be purchased from licensed nurseries. Non-melting flesh peaches recommended for trial in north Florida are 'Gulfking' (Beckman et al. 2005), 'Gulfcrest' (Krewer et al. 2005), 'Gulfcrimson' (Krewer et al. 2008) and 'Gulfprince' (Sherman et al. 2000). These four cultivars are joint releases from the United States Department of Agriculture-Byron, GA; the University of Florida; and the University of Georgia. Of the four Gulf series peaches, 'Gulfking' and 'Gulfcrimson' have the greatest potential (Ferguson et al. 2008).

The non-melting flesh peaches and nectarines with a UF prefix are patented by the University of Florida. 'UFGold' (Sherman and Lyrene 1997), 'UF2000' (Sherman and Lyrene 2000), 'UFBeauty' (Sherman and Lyrene 2003), 'UFBlaze' (Sherman and Lyrene 2003), 'UFO' (Sherman and Lyrene 2001b), and 'UFSharp' (Chaparro et al. 2006) are non-melting flesh peach cultivars. 'UFQueen' (Sherman and Lyrene 1999) and 'UFRoyal' (Ferguson et al. 2008) are non-melting flesh nectarines, suitable for trial in north central Florida. 'UFSun' (Rouse et al. 2004), 'UFOne', and 'UFBest' require 100 - 150 chilling units and are adapted to central Florida (Ferguson et al. 2008; J. Chaparro, pers. comm.).

The agricultural sustainability of peaches and nectarines in Florida is rated as 4 (marginally adapted) due to the high frequency of insecticide and fungicide applications required for successful culture and due to the need to prune and to perform fruit thinning (in the absence of late-winter frosts). Rootstocks that are resistant to the peach root-knot nematode, *Meloidogyne floridensis* (Handoo et al. 2004) are required to ensure orchard productivity. Currently, 'Flordaguard' is the only commercially recommended rootstsock, although other new rootstocks, such as 'Sharpe' (Beckman et al. 2008) and 'MP-29' (Beckman et al. 2012) are available for trials.

Some common insect pests of these trees in Florida are white peach scale (*Pseudaulacaspis pentagona* Targioni-Tozzetti), San Jose scale (*Quadraspidiotus perniciosus* Comstock), greater peach tree borer (*Synanthedon exitiosa* Say), lesser peach tree borer (*Synanthedon pictipes* Grote & Robinson), plum curculio (*Conotrachelus nenuphar* Herbst), two-spotted spider mite (*Tetranychus urticae* Koch) and several species of stinkbugs (*Nezara viridula* L. and *Leptoglossus* spp.) (Mizell 2007b). The brown marmorated stinkbug (*Halyomorpha halys*) has not yet been reported in Florida.

Some common diseases of these trees in Florida include mushroom root rot [*Armillaria tabescens* (Scop.) Dennis, Orton & Hara], *Botryosphaeria dothidea* (Moug.:Fr) (Ces. & de Not), peach scab (*Cladosporium carpophilium* Thuem.), and brown rot (*Monilinia fructicola,* G. Wint) (Horton et al. 2007). Most peaches and nectarines released from the University of Florida breeding program are resistant to bacterial spot (*Xanthomonas campestris pv. pruni*). Peaches are not adapted to south Florida due to inadequate winter chilling in this region and a high probability of fruit-fly damage prior to fruit harvest.

Plum

Although there is no significant plum industry in Florida, the culture of plums offers good potential for homeowners and commercial growers. The University of Florida has released and patented 'Gulfbeauty' (Sherman and Lyrene 1998), 'Gulfblaze' (Sherman and Lyrene 1998) and 'Gulfrose' (Sherman and Lyrene 2001a). These plum cultivars are adapted to north Florida and to north central Florida and are recommended for grower trial. These cultivars are resistant to plum leaf scald (*Xylella fastidiosa* Wells et al.) (Mizell et al. 2012) and bacterial spot (*Xanthomonas campestris pv. pruni*) (Miller et al. 2012, Simone et al. 1995). 'Gulfgold' and 'Gulfruby' are sometimes found in the nursery trade, but are not recommended because of susceptibility to plum leaf scald and bacterial spot, respectively (Miller et al. 2012).

Fruit size of the Florida plums is 1 3/4 - 2 inches in diameter. These fruit begin to ripen in early May, about two weeks before plums from California arrive in the marketplace.

There are many other plums from the Alabama breeding program and elsewhere (eg. 'Au-Cherry', 'Au-Roadside', 'Au-Rosa', 'Au-Rubrum', 'Byrongold', 'Excelsior', 'Methley', 'Ozark Premier', 'Rubusto', 'Santa Rosa', and 'Segundo'). However, most of those cultivars have not been adequately evaluated in north Florida. Those cultivars also have a high chilling requirement, and some are susceptible to plum leaf scald.

Low-chill plums should be propagated on nematode-resistant rootstocks, such as 'Flordaguard' peach or 'Sharpe' plum. The difficulty in growing plums in Florida is somewhat similar to the challenge of growing peaches and nectarines in Florida. For example, plum curculio, peach

tree borers, and stinkbugs are common insect pests (Mizell 2007c), and brown rot is a common disease (Horton et al. 2007). Plums in Florida have a sustainability rating of 4. For more information on plums, consult Miller et al. (2012).

Blueberries

Southern Highbush Blueberry

Southern highbush blueberry (*Vaccinim corymbosum* L. X V. *darrowi* camp) production in central Florida and north central Florida can be highly profitable since berry ripening in April and early May coincides with a period of high demand and low supply. This open market window extends to distant markets in the United Sates, as well as to Europe and also worldwide.

The genesis of the low-chill southern highbush industry is the University of Florida blueberry breeding program. The increase in southern highbush acreage in Florida over the last 20 years, as well as future expansion of this acreage, is influenced heavily by the development of new cultivars.

During the 1980s and early 1990s, 'Sharpblue', 'Misty', and 'Gulf Coast' compmrised most of the highbush blueberry acreage in central Florida and north central Florida (Williamson and Lyrene 1995). Since that time, 'Star', 'Emerald', and 'Jewel' have gradually become the predominant cultivars grown commercially in peninsular Florida. Whiles these cultivars are still important today, there are other cultivar choices available to growers to address specific needs and concerns. Some of these cultivars that fill a particluar "niche" are often included in the overall cultivar mix on commercial farms. Early ripening cultivars include 'Snowchaser', 'Springhigh', and 'Primadonna'. Cultivars that show some potential for mechanical harvest include Meadowlark™ and 'Farthing'. 'Sweetcrisp' has exceptionally high-quality, firm fruit, but yields of 'Sweetcrisp' have been disappointingly low in Florida. The University of Florida breeding program continues to release new cultivars that may be trialed by growers on a limited basis to evaluate their commercial potential (Williamson et al. 2012). 'Bluecrisp', 'Emerald', 'Jewel', 'Millennia', 'Misty', 'O'Neal', 'Sharpblue', and 'Star' have been evaluated in north Florida (Andersen et al. 2008).

'Georgiagem' (Austin and Draper 1987) and 'Oneal' (Ballington et al. 1990) may also be tested in the northernmost region of north Florida (Krewer and NeSmith 2000). For more information, see Andersen et al. 2008 and Williamson and Lyrene 1995, 2004. Blueberry cultivars named since 1995 by the University of Florida breeding program are all patented.

The cultivation of southern highbush blueberries requires attention to detail from proper site selection (and soil amelioration) to pest control. The single greatest impediment to successful production of this berry in Florida is the probability of late winter/early spring frost during bloom and early fruit development. Consequently, it is necessary for growers to use overhead irrigation to reduce the probability of frost injury. The likelihood of frost injury and later berry ripening in north Florida has reduced profitability for this fruit in this region (Andersen, 1995a).

Other limitations for cultivation of southern highbush blueberry in Florida include a requirement for soils with a low pH and high organic-matter content. Pest control (insects, disease, and birds) also needs to be considered. Lastly, high labor requirements are involved in hand harvesting of this berry.

The limitations are consistent with southern highbush blueberries placement in the moderately adapted category. As such, this berry has been assessed as 5 in terms of agricultural sustainability in Florida.

Rabbiteye Blueberry

Acreage of rabbiteye blueberries (*Vaccinium virgatum* Aiton) in Florida has not expanded substantially during the last 20 years, largely as a result of competition with North Carolina's highbush industry. Although the University of Florida breeding program has emphasized development of early-ripening rabbiteye, such cultivars have a lower chilling requirement so often sustain frost injury in late winter.

The rabbiteye blueberry, native to north Florida, is resistant to most insect and disease pests in this region. Rabbiteye blueberries are, therefore, classified as a highly sustainable crop for north Florida (i.e. sustainability of 9). In Gainesville and further south, however, the culture of rabbiteye blueberries can be more difficult due to inadequate chilling in certain years and perhaps due, as well, to enhanced insect and disease pressures in areas south of north Florida.

While rabbiteye blueberries are more vigorous than highbush blueberries and have less-exacting soil requirements, rabbiteye blueberries are labor intensive. Most operations are hand-harvested. For Gainesville and northward in Florida, alternating rows of 'Climax', 'Bluegem', 'Brightwell', and 'Powderblue' have been recommended for the fresh market, utilizing machine harvesting (Williamson and Lyrene 1995, 2004).

For pick-your-own operations, recommended rabbiteye blueberry cultivars include the following: 'Austin', 'Climax',

'Chaucer', 'Woodward', 'Bluebelle', 'Bluegem', 'Brightwell', 'Powderblue', and 'Premier' (Williamson and Lyrene, 1995, 2004). For the northernmost portions of the north Florida region, Andersen (1995a) recommended 'Woodard', 'Premier', 'Powderblue', 'Tifblue', and 'Brightwell'. Chilling-induced problems with fruit seldom occur in those northernmost portions of the state although late spring frosts have reduced yield of cultivars with a low-chilling requirements (Andersen, 1989, 1995a, Andersen et al. 1991). 'Arapaho', 'Austin', 'Brightwell', 'Climax', 'Ira', 'Ochlocknee', 'Powderblue', 'Premier', 'Savory', and 'Yadkin' were evaluated in north Florida (Andersen et al. 2009). 'Brightwell' produced the highest yield, 'Savory' produced the largest berry size, and 'Climax' produced the highest sugar content.

Grapes

Muscadine Grapes

Muscadine grapes (*Vitis rotundifolia* Michx.) are native to north Florida and are a sustainable crop in the southeastern United States as a minimum of agricultural inputs (beyond vineyard establishment) are required for successful production (Andersen et al. 2010). Successful crops of muscadine grapes can be grown in north Florida without any insecticide or fungicide applications.

The decline in muscadine-grape acreage in Florida in the last fifteen years has been related to low demand and low prices paid for fruit destined to be processed into juice and wine. However, U-pick operations based on large-fruited cultivars are still viable economic entities. Muscadine grapes are also shipped to moderate-distance markets as far as Miami.

Muscadine cultivars that are rated highly for the fresh market include the following: 'Farrer', 'Fry', 'Granny Val', 'Jumbo', 'Ison', 'Summit', 'Nesbitt', 'Polyanna', 'Supreme', 'Black Fry', 'Early Fry', 'Pam', 'Black Beauty', 'Pineapple', and 'Sweet Jenny'. All of the above cultivars -- except 'Fry', 'Jumbo', 'Summit', 'Nesbitt', and 'Polyanna' -- are patented by Ison's Nursery.

The fresh market grapes 'Late Fry', 'Ison', 'Nesbitt', 'Florida Fry', 'Granny Val', 'Ison', 'Pineapple', and 'Polyanna' are self-fertile and do not require a pollinizer cultivar. 'Farrer', 'Fry', 'Jumbo', 'Summit', 'Supreme', 'Black Fry', 'Early Fry', 'Pam', 'Black Beauty', and 'Sweet Jenny' are pistillate cultivars and require a pollinizer. 'Noble', 'Welder', and 'Carlos' are self-fertile and are the best muscadine juice and wine grapes (Andersen et al. 1989, 1991, 2010; Olien, 1990).

Quantitative data on the performance of new muscadine grape cultivars are now available (Andersen et al. 2010).

Bunch Grape

Bunch-grapes hybrids (*Vitis* hybrids) developed by the University of Florida breeding programs were promoted during the 1980s as a substitute for high-quality European (*Vitis vinifera* L.) or American (*Vitis labrusca* L.) grapes (Andersen et al. 2011). These latter two species cannot be grown in the southeastern United States due to susceptibility to a disease caused by a gram-negative bacterium (*Xylella fastdiosa* Wells et al.) and vectored by leafhoppers (Mizell et al. 2012, Momol et al. 2007b, Simone et al. 1995). Poor yield and quality, as well as a lack of disease resistance, are major reasons for the drastic decline in bunch-grapes acreage in Florida. Bunch grapes are attacked by numerous fungal diseases, the most serious of which is anthracnose (*Elisone ampolina* Shear) (Momol et al. 2007b). Bunch grapes are among the least-sustainable crops that can be grown in Florida. Bunch grapes require numerous pesticide applications (Liburd et al. 2004, Momol et al. 2007b). Moreover, no other crop has more worldwide competition.

'Stover', 'Suwannee', 'Blanc du Bois', 'Black Spanish', and 'Conquisitor' are mainly planted for wine production (Crocker et al. 2008). 'Daytona', and 'Orlando Seedless' are fresh-market bunch grapes grown in Florida.

Apple and Pear

Apples (*Malus domestica* Borkh.) and pear (*Pyrus serotina* L.) trees are not significant economic entities in Florida due to the year-round availability of high-quality apples and pears from the Pacific Northwest. However, low-chill cultivars of apples ('Anna', 'Dorsett Golden', and others) are often grown by homeowners in Florida (Andersen and Crocker 2009). A patented low-chill apple, 'TropicSweet', has also been released from the Florida breeding program (Sherman and Lyrene 1996). Most apple cultivars require cross-pollination.

Pear cultivars adapted to north Florida and north central Florida include 'Flordahome', 'Hood', 'Tenn', 'Baldwin', 'Kieffer', 'Orient', and 'Pineapple' (Andersen 1990, 1991, Crocker and Sherman 1986). 'Baldwin', 'Kieffer', 'Orient', and 'Hood' are self-fruitful. However, 'Flordahome' and 'Pineapple' require cross-pollination.

All cultivars of apples and some cultivars of pears are susceptible to many fungal diseases. The most serious diseases of apple and pear include white rot (*B. dothidea*), black rot (*Botryosphaeria quercuum* (Schwein) Sacc),

pear leaf spot (*Fabraea maculata*) and Cercospora leaf spot (*Pseudocercospora mali* Ellis & Everh.) (Momol et al. 2007a, Simone et al. 1995). Apples are rated as a marginally adapted species for Florida and have a sustainability rating of 3. Some pear cultivars can be grown without pesticides, and pears have a moderate sustainability assessment of 5.

Oriental Persimmon

Interest in oriental persimmons (*Diospyros kaki* L.) has increased greatly in north Florida and north central Florida with the introduction of non-astringent cultivars from Japan (Miller and Crocker 1994). Consumer demand is sufficiently high, such that virtually all persimmons that are grown in Florida are marketed locally. Both local and distant markets have created an opportunity for an expansion in persimmon acreage in Florida.

The major impediments to successful persimmon culture in Florida are fungal diseases (*Cephalosporium diospyri* Crandell, *Cercospora* spp. and *B. dothidea*) (Miller and Crocker 1994) and insect pests (wood borers, pyslla and both soft and armored scale pests) (Mizell and Brinen 2007). As a result, oriental persimmons are marginally adapted to north Florida and north central Florida and have a sustainability rating of 5.

Miller and Crocker (1994) recommended 'Izu', 'Mastsumoto Wayse Fuyu', and 'Fuyu' for trial in north Florida and north central Florida. Andersen (1993b) reported that 'Fuyu' was the best persimmon cultivar for north Florida.

Blackberry

Blackberries (*Rubus* spp.) have been grown in small-acreage plots throughout the northern part of Florida for many years. Consumer demand is extremely high; however, the culture and management of blackberries is labor intensive. Perhaps the most serious disease of blackberries is double blossom (*Cercosporella rubii* (Win., Plak)), followed by anthracnose (*Ellisone veneta* (Burkh.) Jenk.) and rust (*Gymnoconia, Kuehneola* and *Kunkelia* spp.) (Andersen 2011, Simone et al. 1995). Insect pests include cane borers, thrips, mites, aphids, flea beetles and stinkbugs (Mizell 2007d). Blackberries are rated a 6 in terms of agricultural sustainability.

At the University of Florida's North Florida Research and Education Center (NFREC) in Monticello, Fla., thornless blackberry cultivars have been grown successfully without the application of pesticides (Andersen 2011; Andersen et al. 1995).

Prior to 1985, blackberries grown in Florida were cultivars released from the University of Florida, such as 'Oklawaha', 'Flordagrand', and also 'Brazos' from Texas (Sherman and Arnold 1973). However, recent introductions in north Florida of blackberry cultivars from the University of Arkansas have become increasingly popular. Most of the University of Arkansas' cultivars are resistant to double blossom. The thorny cultivars include 'Shawnee' (Moore et al. 1985) and 'Kiowa' (Moore and Clark 1996). Thornless blackberry cultivars include 'Arapaho' (Moore and Clark 1993), 'Navaho' (Moore and Clark 1993), 'Apache' (Clark and Moore 1999a), 'Ouachita' (Clark and Moore 2005), and 'Natchez' (Clark and Moore 2008). All of the blackberries from the University of Arkansas are patented. The southern limit of adaptation for these cultivars appears to be north Florida.

Mayhaw

Mayhaw (*Crataegus aestivalis* (Walter) Torr. & A. Gray, *Crataegus rufula Sarg.* or *Crataegus opaca* Hoak. & Arn.) produces small apple-like fruit that ripen in late April or early May in Florida. This specialty fruit is mainly used for making jelly. The species can grow in swampy areas and will grow as far south as Lake County, Fla., which is immediately north of Orlando.

There is low potential for expansion in commercial mayhow acreage in Florida although there is potential for expansion in direct-to-consumer outlets.

Mayhaw cultivars for the southeastern United States include the following: 'Lori', 'Lindsey', 'Big Red', 'Red and Yellow', 'Heavy', 'Mason's Super Berry', 'T. O. Super Berry', 'Highway Super Berry', and 'Super Spur' (Krewer et al. 1993). Mayhaw is native to the southeastern United States and has relatively few pest problems in this region. Perhaps the two greatest pests of mayhaw are plum curculio and deer. Mayhaw is rated as a sustainable crop for Florida.

Chestnut

Chinese chestnuts (*Castanea mollisima* Blume) and Chinese chestnut x American chestnut crosses can be grown in Florida (Hochmuth et al. 2012). Many small plantings of the chestnut are in the Gainesville area.

The chestnuts must be harvested every other day and stored under refrigeration because of fungi and bacteria that will attack the nuts on the ground. The nuts should be stored under high-humidity refrigeration to prevent the nuts from

drying and becoming too hard to eat. Gloves should be used when harvesting because of the spines on the nut burr.

Demand for chestnuts is high and some expansion in chestnut acreage in Florida is likely. Chestnuts have relatively few pest problems and are a fairly sustainable crop for north Florida and north central Florida. 'Revival', 'Carolina', 'Williamette', and 'Heritage' are some cultivars available for trial (Brinen, 2007). Due to a problem with graft incompatibility, seedlings are now often being sold in the nursery trade (Bob Wallace, personal communication).

Fig

The fig (*Ficus carica* L.) is not a commercially important crop in north Florida, nor is it likely to be commercially important in Florida in the future. Virtually the entire fig acreage in Florida is in homeowner settings. The greatest limitation to fig production in Florida is due to winter freezes or late winter frosts, which generally prevent figs from growing into a tree form. This effect of cold weather on fig trees is why they are commonly thought of as a bush, rather than as a tree. However, other than nematode susceptibility, figs do not suffer many serious insect or disease pests. As a result, figs were rated a 7 in terms of agricultural sustainability in Florida.

The most common fig cultivars include 'Brown Turkey' and 'Celeste'. 'Conadria', 'Jelly', 'Pasquale', and 'Tena' have also been grown with success at the NFREC in Monticello, Fla. (Andersen 1993a).

Citrus

From both a homeowner and a commercial perspective, there has been a resurgence of interest in growing cold-hardy citrus in north Florida and north central Florida. Prior to the 1980s, mature specimens of satsuma (*Citrus unshiu* Marcovitch) were not uncommon in north Florida. Since then, however, three major freezes virtually eliminated citrus in this region.

Satsuma

Since 1990 new plantings of satsuma have been established in north Florida. Several cultivars of satsuma include 'Owari' (most popular), 'Brown Select', 'Kimbrough', 'Silverhill' and 'Xie Shan' (Ferguson, 1996).

Satsuma cultivars north of Ocala should be grafted on *Poncirus trifoliata* rootstocks. When properly conditioned to the cold, satsuma are hardy down to about 15°F. Fruit are usually harvested in late November/early December, thereby avoiding freeze damage to the fruit. For homeowner citrus plantings, trees should be planted on the south side of a house or other structure to minimize exposure to cold north or northwest winds. Soil can be mounded in a pyramid around the trunk of a tree in during extremely cold conditions. Alternatively, for small trees, one can place a large garbage can or a portable structure over the top and place a 60-watt lightbulb on the ground under the shelter to warm the tree in cold weather. This practice will protect a young tree under any conditions that may occur in north Florida.

In north Florida and north central Florida, satsuma is a sustainable crop compared to apple and peach and requires relatively few pesticides. Satsuma is assigned a sustainability rating of 8.

Citrus leaf miner (*Phyllocnistis citrella* Stainton) and citrus scab (*Elsinoe fawcetti* Bitancourt and Jenkins) may be the most common pests of citrus in north Florida.

For more information on cold-hardy citrus consult Ferguson (1996, 2002) and Rouse and Zekri (2002).

Kumquat

Kumquat (*Fortunella x crassifolia*) is another type of citrus adapted to north Florida. Kumquat is at least as cold-hardy as satsuma. 'Meiwa', 'Nagami', 'Murumi', and 'Hongkong' are some of the available kumquat cultivars. The culture and management of kumquat is similar to that described for satsuma. Kumquat is relatively pest free and has a sustainability rating of 8.

Olives

Olives have been successfully grown in north Florida. Most olives are pressed for olive oil. Approximately 25 pounds of olives yield about 1 liter of olive oil. 'Arbequina', 'Arbosana', 'Koroneki', 'Manzanillo', and 'Mission' are being grown in north Florida/south Georgia. Thus far, olives are a sustainable crop (rating of 8), although profitability has not been established.

Pomegranate

Although pomegranate have been grown in the southeastern United States, there is no commercial industry. There is renewed interest and increased demand for fresh fruit, juices, and other products. They appear to be a sustainable crop, but more information is needed.

Conclusion

Few cultivars of deciduous fruit and nut trees available for sale locally are sufficiently adapted to Florida's humid, subtropical climate to be grown in a sustainable manner. Limitations to successful culture may occur in the form of adverse climate (high humidity, high temperature, or the lack of winter chilling, high risk of late winter/early spring frosts), soil conditions or intense insect and disease pressures.

For a marginally adapted species, many of these barriers can be overcome with a substantial investment of resources and labor. Non-adapted species will experience servere limitations so as to preclude successful culture. The more similar the climate and soils of given species' native range to those of Florida, the more successful the species will likely be in Florida.

Native species such as muscadine grapes (*Vitis rotundifolia* Michx.) or rabbiteye blueberries (*Vaccinium virgatum* Aiton) have more potential for sustainable production in Florida whereas apples (*Malus domestica* Borkh) or low-chill peach (*Prunus persica* (L). Batsch), native to Asia, require substantial agricultural inputs to be grown successfully in Florida.

Certain commodities that offer the highest growth potential and net profitability require substantial agricultural inputs. Peaches, nectarines and southern highbush blueberries that ripen during an early market window (1 April to 15 May) are examples of crops with high profit potential. However, these crops rank rather low in terms of sustainability in Florida.

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Table 1. Adapted and Marginally Adapted Species for North Florida and North Central Florida

Fruit Crop	Approximate Acreage[x]		Reasons for Increase/Decrease in Acreage	Commercial Potential	Direct-to-Consumer Potential	Assessment of Agricultural Sustainabilty[y]
	2009	1985				
Pecan [*Carya illinoensis*(Wangenh.) C. Kock]	7500	15000	Disunity among growers (poor marketing strategies); enhanced disease pressures;long period required for return on the investment. Much acreage has been subdivided, and muchof that remains is not intensively managed.	Low	Low to moderate	5
Peach/Nectarine [*Prunus persica* (L.) Batsch]	300	2500	Unstable weather patterns; poor choices of cultivars untilrecently; reduced consumerdemand competition from California after mid-May.	High	High	4
Plum (*Prunus salicina* L.)	5	5	New plum leaf scald-resistant cultivars are now available. Impediments include susceptibility to late-winter frosts and insect and disease limitations.	High	High	4
Highbush blueberry (*Vaccinium hybrid*)	3000	200	Excellent market niche for fresh market shipment nationally and internationationally in April and early May for highbush blueberryproduction in central and north central Florida.	High	Moderate	5
Rabbiteye Blueberry (*Vaccinium virgatum* Aiton)	1000	1000	Acreage has not increased due to competition from highbush blueberry production in North Carolina; high laborrequirements.	Moderate	High	9
Muscadine Grape (*Vitis rotundifolia*Michx.)	400	700	Low demand; limited consumer acceptance; low prices offeredfor wine or juice. Onlylarge - fruited cultivars for fresh market are profitable.	Low	Moderate	8
Bunch Grape (*Vitis* hybrid)	50	600	Low yield per hectare; poor disease resistance; highcompetition from grapesproduced worldwide.	Very Low	Very Low	2
Apple (*Malus domestica* L.)	5	20	Poor quality; high insect and disease pressure. High-quality fruit are available 12 months/yrfrom the Pacific Northwest.Some home-garden potential.	Low	Low	3
Pear (*Pyrus serotina* L, P. *communis* L.)	20	50	Poor quality; high disease pressure. High quality available12 months/year from West Coast. Some potential as adooryard fruit.	Low	Low	5
Oriental persimmon (*Diospyros kaki* L.)	200	100	High consumer demand for fresh market non-astringentoriental persimmon; demand forastringent types is not high.	Moderate	High	5
Blackberry (*Rubus* spp.)	20	20	New cultivars from Arkansas breeding program offer potentialfor north Florida growers;thornless cultivars also offer potential.	Moderate	High	6

Chestnut (*Castanea mollisima* Blume)	150	10	Specialty crop with high consumer demand; the need forfrequent harvest (i.e. high laborand perishability may limit expansion). Chestnut is resistant to most insects and diseases.	Moderate to High	Moderate to High	7
Mayhaw (*Crataegus* spp.)	15	1	Specialty crop with high consumer demand.	Low	Moderate	7
Fig (*Ficus carica* L.)	10	10	High incidence of freeze and frost damage to vegetativetissues. Some potential as a dooryard fruit.	Low	Low	7
Satsuma (*Citrus unshiu* Marcovitch)	100	2	Cold-hardy citrus that is relatively pest free. Fruit aremostly seedless with ripening in November/ December.	High	High	8
Kumquat (*Fortunella x crassifolia*)	2	2	Kumquats are at least as cold hardy as Satsuma. Relatively pest free. Specialty crop.	Moderate	High	8
Olives (*Olea europaea* L.)	10	0	Relatively easy to grow with relatively few pests. Profitability has not been established.	Not known	Moderate	8
Pomegranate (*Punica granatum* L.)	5	2	Pomegranate have been grown as dooryard trees for many years. Increased interest due to antioxidant content. Relatively pest free.	Moderate	Moderate to high	8

[x] Approximate acreage and potential for expansion based on estimates by P.C. Andersen, T.E. Crocker and J.G. Williamson.
[y] Assessment of agricultural sustainability by P.C. Andersen, T.E. Crocker and J.. Williamson. Assessment of agriculturalsustainability incorporates all necessary inputs (water, pesticide, fertilizer, trellises, mulches, etc.) for successful production based on a scale of 1 - 10 with 1 = least sustainable and 10 = most sustainable.

Table 2. Non-Adapted Species for Florida and Limitations to these Species' Successful Culture in Florida

Species	Limitations
Almond (*Prunus amygdalus* Batsch)	High-humidity-induced fungal disease; almond leaf scorch.
Apricot (*Prunus armeniaca* L.)	Unreliable cropping due to inadequate chilling and fluctuating temperatures during winter.
Cherry Sweet (*Prunus avium* L.) Sour (*prunus cerasus* L.)	Inadequate chilling; foliar disease.
Cranberry (*Vaccinium macrocarpon* Ait.)	Lack of winter chilling. Requires low temperatures during the growing season and low pH soils with high organic matter.
Filbert (*Corylus avellana* L.)	High incidence of frost damage to flowers that bloom during the winter; high induced foliar diseases.
Grapes (*Vitis vinifera* or *V. labrusca*)	Pierce's disease; many diseases associated with high summer temperatures, humidity and rainfall.
Kiwi (*Actinidia deliciosa* A. Chev.)	Unreliable cropping due to inadequate winter chilling and spring frosts.
Pistachio (*Pistacia vera* L.)	High-humidity-induced foliar diseases. Inadequate winter chilling.
Raspberry (perennial) (*Rubus* spp.)	Only one cultivar can tolerate hot humid conditions of the southeastern United -- 'Dorman Red', and its quality is poor.
Walnut English (*Juglans regia* L.)	High-humidity-induced foliar diseases. Inadequate winter chilling.
Walnut Black (*Juglans nigia* L.)	Can be grown successfully in good soils located in extreme north Florida. Quantitative data are needed.