

Hurricane Katrina: Perspective from the Southern Horticultural Laboratory

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Abstract. Surviving extremes of climate is a fundamental component of horticultural production and research. The Southern Horticultural Laboratory has weathered many storms including Hurricane Camille and now Hurricane Katrina. The name of the research station has changed twice, both times following massive hurricanes. Before Hurricane Camille in 1969, the station title was the Tung Research Unit. After the devastation of the tung industry by Camille, the research focus changed to blueberries and other small fruit crops with a corresponding name change to Small Fruit Research Unit in 1976. The research objectives expanded to include ornamental research in 2001. Post Hurricane Katrina, the unit was renamed the Thad Cochran Southern Horticultural Laboratory to reflect the station's expanded research mission. This paper chronicles how the station reacted to the devastation of Hurricane Katrina. It also evaluates economic vitality of commodities researched at the station in contrast with storm effects on pecan and the demise of tung production. Katrina produced some temporary interruptions in production but no drastic restructuring of the type experienced with tung production after Camille is anticipated. Hurricanes are inevitable for the Gulf Coast region. Wise planning and implementation of preventative measures to protect horticultural crops and research will determine future success.

The ability to survive extremes of climate is an important consideration in horticultural production and research. In many sections of the U.S., catastrophic losses generally occur in the winter due to extreme drops in temperature, ice storms and blizzards. Extended periods of extreme summer heat, usually accompanied by reduced rainfall, also have dramatic effects on yield and plant health. Hurricanes may be considered the ultimate stress factor because they occur suddenly when plants are in active growth and inflict a range of traumas.

Over the past 30 years, coastal states from North Carolina to Texas have experienced consistent growth in the production of horticultural crops. Producers have been attracted to this region due to long growing seasons, mild winters and proximity to growing population centers. Coincidentally, this is the area most likely to be struck by a major hurricane (Blake et al., 2005).

Severity of hurricanes is characterized into one of five categories using the Staffer/Simpson Hurricane Scale, which determines destructive energy of a storm based on barometric pressure, wind speed and surge (Simpson, 1974).

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Category 1 and 2 storms generally cause little property damage while 3, 4, and 5 cause major losses. Since there is not a one-to-one correlation between any of the elements used by the Staffer/Simpson Hurricane Scale, the National Weather Service's Tropical Prediction Center uses maximum wind speed to categorize hurricanes. Heavy rainfall associated with a hurricane is not a criterion used to categorize a storm, but can play a major role in crop and property losses. The U.S. hurricane season

extends from June through November with the peak, in number and severity, occurring from the middle of August through the end of September (Blake et al., 2005). Weather records, dating back to 1851, reveal that on average three major hurricanes made landfall somewhere along the Atlantic and Gulf of Mexico coastlines every 5 years. Fluctuations in storm frequencies and intensities observed over time have been linked to other cyclic climatic phenomena such as changes in ocean currents and stratospheric oscillations (Pielke and Landsea, 1999). A recent study indicates that over the past 30 years a cycle of hurricanes with increased destructive potential has occurred and may continue due to increases in sea surface temperatures (Emmanuel, 2005). The 2005 storm season was the most active on record with 28 tropical storms of which 3 major hurricanes made landfall in the U.S. Of these, Hurricane Katrina is rated as one of the most destructive and expensive natural disasters in U.S. history.

Winds and excessive rainfall generated by hurricanes induce initial stress to horticultural crops and destroy production infrastructure. Winds within hurricanes in the southeastern United States initially blow from the northeast due to counterclockwise rotation around the eye, then shift to the southwest as the storm passes. The most destructive winds are on the right side of the eye. The 180° shift in wind direction during a storm can twist plants, seriously damaging root systems or completely uprooting trees. Strong winds also break limbs and strip leaves and fruits from plants. Tornadoes are often spawned as hurricanes pass, which generate zones of more intense destruction within the storm path. Storm surge and salting near the coast produce a different spectrum of stress than the much larger pattern of wind damage and flooding due to rainfall. Hurricanes in the southeast have impacted production areas up to 400 km inland with wind speeds up to 175 km·h⁻¹ and torrential rains (Reighard et al., 2001). Over the past decade, papers have described damage and suggested cultural practices for preventing and correcting storm damage to various orchard crops (Crane et al., 2001; Reighard et al., 2001; Wood et al., 2001). Any major hurricane has both immediate and long-term effects on horticultural production and research.

Reacting to Hurricane Katrina

Friday 27 Aug. 2005 was a typical workday at the Southern Horticultural Laboratory in Poplarville, Miss., which is 100 km northeast of New Orleans,

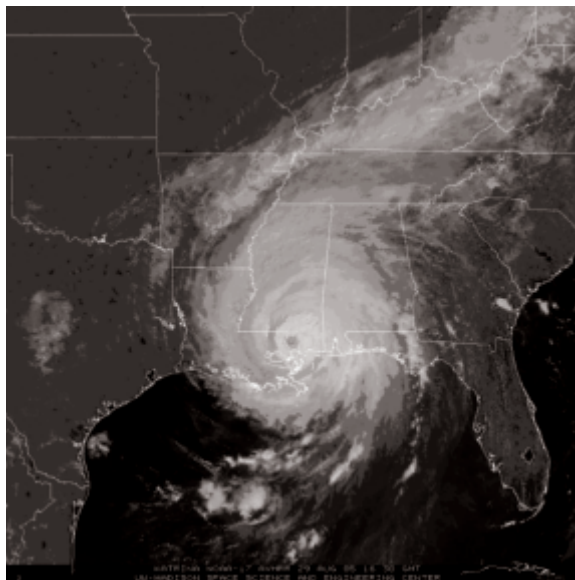


Fig. 1. Hurricane Katrina as the eye passes over the Southern Horticultural Laboratory showing region primarily affected by the storm (<http://cimss.ssec.wisc.edu/tropic/tropic.html>).

La. The focus of the laboratory is to conduct production and breeding research in support of ornamental and small fruit production. Hurricane Katrina had already crossed south Florida into the Gulf of Mexico and was expected to track north, west of the Florida Peninsula, before coming ashore east of Tallahassee. Although people in the region were aware of the storm, they were not concerned because the forecast indicated the hurricane was heading towards Florida. By Saturday morning, the expected track of Katrina had shifted west. Wind speeds had increased and landfall was expected to occur on Monday between Mobile, Ala., and New Orleans.

Sunday was a day of preparation. How does one prepare for a hurricane at a horticultural research station? People in the area were told to board up windows, secure loose items in their yards, that could be blown around by wind, and evacuate. There was little, if anything that could be done to reduce damage to the field plots, but greenhouses and containerized plants needed preparation to reduce damage. Much of the containerized plants were seedlings from the breeding programs and germplasm that would be difficult or impossible to replace. Commercial growers who had experienced previous hurricanes in other areas of the South indicated that reducing wind damage and keeping plants watered after the storm were the primary factors associated with plant survival. We first watered all containerized plants. Then, those that were >33 cm tall in height were laid down facing south to north to minimize wind drag on foliage. Shade cloths and polyethylene covers were removed from greenhouses where possible. Available trash cans were filled with water to use after the storm. Sunday afternoon was a beautiful late-summer day in south Mississippi with no indication of the impending doom that was churning toward us in the Gulf of Mexico. There was nothing else that could be done except join the caravan headed north or go home and prepare to weather the storm.

Monday was a day of survival. Strong outer bands of the storm started moving through the area around 4 AM. Electricity went off shortly thereafter. Wind speed increased throughout the morning until 11:30 AM when the eye of Hurricane Katrina was over Pearl River County, which is where the Southern Horticultural Laboratory is located (Fig. 1). In the eye of the storm the wind stopped blowing, the rain stopped and the storm seemed to be over. Wind speed picked back up again and rain resumed after 30 min to 1 h and continued until about 4:30 PM.

Tuesday was a day of shock. It wasn't until afternoon before many roads were opened to traffic and damage to the station and the community could be evaluated. In <12 h Katrina, a very strong category-3 storm, had changed the landscape dramatically. Strong winds from the east had blown down huge oak trees, ripping their roots from the ground. Many pecan trees that were loaded with nuts had many primary limbs broken or were uprooted and blown to the ground (Fig. 2). Trunks of pine trees were broken like wooden match sticks at various heights, from the ground to the top of

the tree. All roofs in the Poplarville area had some damage—from a few missing shingles to large sections crushed by trees or blown away by wind. Roads were blocked by fallen trees, utility lines and assorted roofing materials.

Structures at the research station had weathered the storm in much the same manner as those in the surrounding community. Three of ten greenhouses were completely destroyed (Fig. 3). These were structures with fiberglass coverings that could not be removed before the storm. Most of the damage to the other structures was associated with covered end walls that caught the wind and warped or tore away parts of the greenhouse frame. Side support posts were shifted to the west in a newly constructed greenhouse that had 3.3-m-tall sidewalls for increased summer ventilation. It was apparent that the vertical posts should have been anchored in more cement. A large section of the roof of the equipment shed was blown off in a large section that had miraculously skipped over several greenhouses before landing in a road some 140 m away. Containerized plants that had been laid down had little leaf damage. Trellises in the muscadine vineyard were damaged but vines had weathered the storm with only moderate damage; only 5 of 600 vines were severely damaged. Some fruit remained on vines. Blueberry and crapemyrtle plant losses in field plantings were minor aside from leaf damage.

Wednesday was a day of discovery. Staff members in charge of maintaining the electrical and water systems were dealing with personal losses associated with the storm and were not available to assist with repairs. With the cloud cover gone, temperatures rose to 32 °C or higher in the day. Both electricity to run the station pump and the municipal water system that supplied some of the station's water were off. Structural damage to greenhouses and flying debris had broken water lines at multiple locations. Automated systems were offline without electricity.

Containerized plants were picked up in preparation for watering, either by rain or by irrigation after the water system was repaired. A few plants were hand watered using water that had been stored in trashcans prior to the storm. Shade clothes were replaced over greenhouses to reduce water loss.

To save plants from severe damage or death, two problems had to be quickly addressed. Leaks in the irrigation system had to be repaired and water had to be pumped. Luckily the local hardware store opened by flashlight allowing us to purchase a range of fittings and pipe sizes for making repairs. On Thursday, the municipal

water system returned limited service to the station, providing enough water to hand water with a hose but not enough pressure to run a single sprinkler. High priority plants were watered by hand for two days. On Friday, a large generator adequate to power a 3-phase commercial submersible pump arrived and by late afternoon Mississippi State University's well at the adjacent South Mississippi Branch Experiment Station was supplying enough water to irrigate several sections at a time. On Monday, one week after Katrina, electrical service was returned to the station and normal watering could resume with the return of the station's large pump to service. Some areas within a few miles of the station were without electricity for 3 weeks.

Although we were not prepared at the station to provide water to our plants after the storm, we were able to improvise with the resources that became available. From our experience in dealing with the after-effects of Katrina, we have identified items that should



Fig. 2. Greenhouses destroyed by Hurricane Katrina at the Southern Horticultural Laboratory.



Fig. 3. Many pecan orchards in southern Alabama, damaged by winds and tornadoes from Hurricane Katrina.

be obtained prior to dealing with a natural disaster at a research station: an onsite, easily activated generator for water well pump; a map of the irrigation system showing valves and solenoids; and, adequate fittings and pipes in sizes needed to repair broken water lines. Disaster planning can be overdone and become as problematic as no plan. The more complicated the plan, the greater potential

for unanticipated variation in a disaster to negate the plan. Identify and provide the essentials and react to the situation. Millions of dollars in research investment are at risk when a horticultural research station is hit by a severe hurricane. Adequate preparation for a hurricane will reduce both people and plant stress when "We will worry about that tomorrow" is today.

Deja Vu

It is easy to identify the immediate damage inflicted on horticultural crops and production facilities after a severe storm such as Katrina, but there are also long term effects that are not initially apparent. The Poplarville research facility was originally established to support tung (*Aleurites fordii* Hemsl) production. Oil extracted from the nuts was initially used for waterproofing wood, paper, cloth, or other porous materials. In 1904 trees were sent from China to California and distributed throughout the U.S. for adaptability trials. Tung grew well and seemed best suited in the Gulf states. Due to increasing interest in tung production, the USDA began an extensive research program on tung production in 1938 utilizing laboratories in Georgia, Florida, Alabama, Louisiana, and Mississippi. With the outbreak of World War II tung oil became an important commodity for defense use. The government aided farmers to produce more and better trees. By the 1950's more than 30,000 ha of tung were in production, with Mississippi and Florida having the greatest acreage (Panshin et al, 1950). Production was good, except in years of spring freezes (Fig. 4). Hurricane Camille hit the Mississippi gulf coast on 17 Aug. 1969 destroying at least half the orchards. Cheaper imports from Argentina had already surpassed domestic tung production prior to the hurricane and the industry never recovered (Kilby and Converse, 1970). Most scientists working on tung either retired or transferred out of the Poplarville unit after the hurricane. Within 2 years after Camille, the Tung Research Station in Poplarville was left with one newly hired scientist fresh from Texas A&M University (Dr. Jim Spiers), one technician, one secretary, and no crop left to research.

Transition of Research after Hurricane Camille

Beginning again seemed an overwhelming task. Moving forward would mean finding another crop to replace the tung industry for small farmers in the Gulf States. Several crops were evaluated such as kenaf, forage grasses and blueberries. In 1970, Don Scott, Investigation Leader for Small Fruit, and Arlen Draper, Research Geneticist working on blueberries, from USDA's Beltsville Research Center, visited the Poplarville location. Together with J. Spiers, they assessed the potential for new crops that can be used to overcome the economic loss (J. Spiers, personal communication). Blueberries were one of the crops USDA-ARS believed to have economic potential for the southern states. In 1971, the first blueberry plants were planted and research began. The station also worked on kenaf, forage grasses, strawberries and blackberries. From 1970 to 1976 Spiers and Draper cooperated to develop cultural practices and new rabbiteye blueberry cultivars adapted to the South. In 1975, Spiers was asked to choose a single path of research for the unit. With the required background in forage grasses, and none in blueberries, it would have been a safer choice to choose forage grasses. There was research being done in many locations on

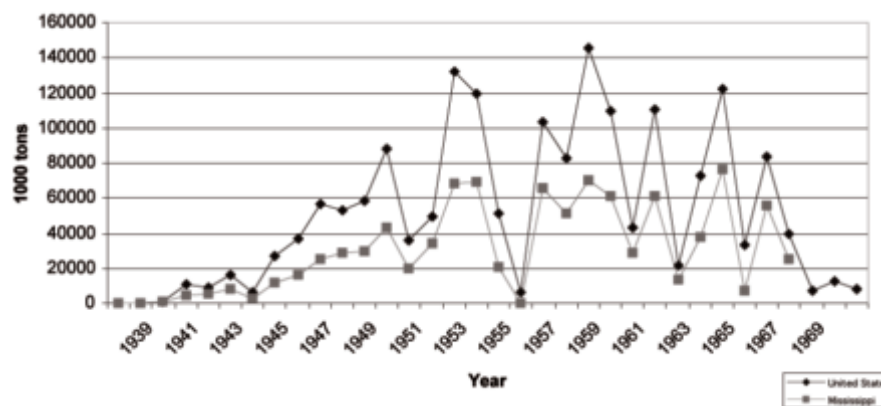


Fig. 4. Comparison of annual national tung production to MS production from 1939 until 1969 when Hurricane Camille decimated orchards.

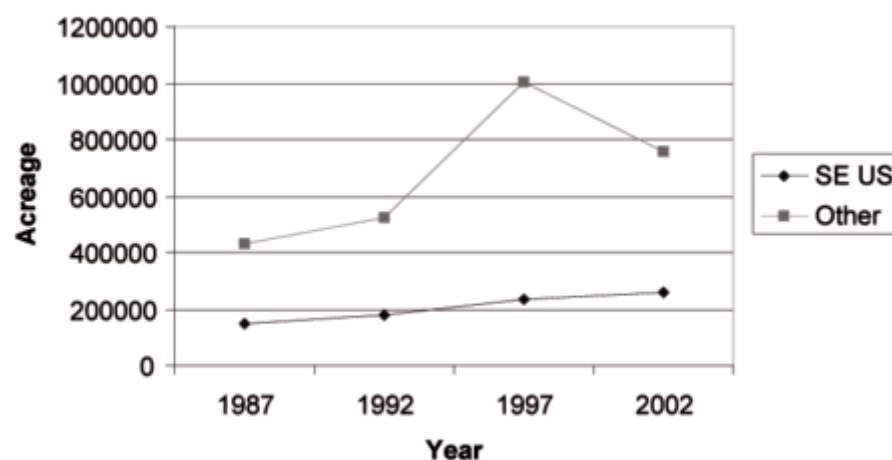


Fig. 5. Comparison between acreage devoted to ornamental production in the southeastern U.S. to other regions of the U.S. (Census of Agriculture 1987, 1992, 1997, 2002).



Fig. 6. Recently completed Thad Cochran Southern Horticultural Laboratory located in Poplarville, Miss.

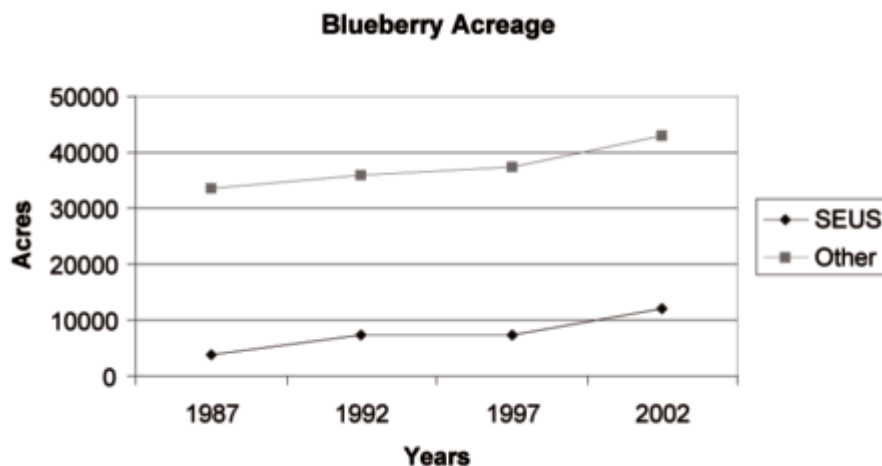


Fig. 7. Comparison between acreage devoted to tame blueberry production in the southeastern U.S. to other regions of the U.S. (Census of Agriculture 1987, 1992, 1997, 2002).

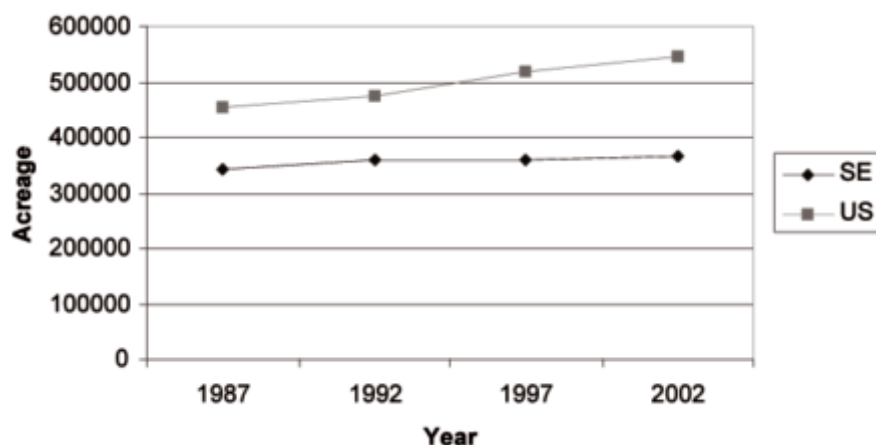


Fig. 8. Comparison of acreage devoted to pecan production in the southeastern U.S. to the remainder of the U.S. (Census of Agriculture 1987, 1992, 1997, 2002).

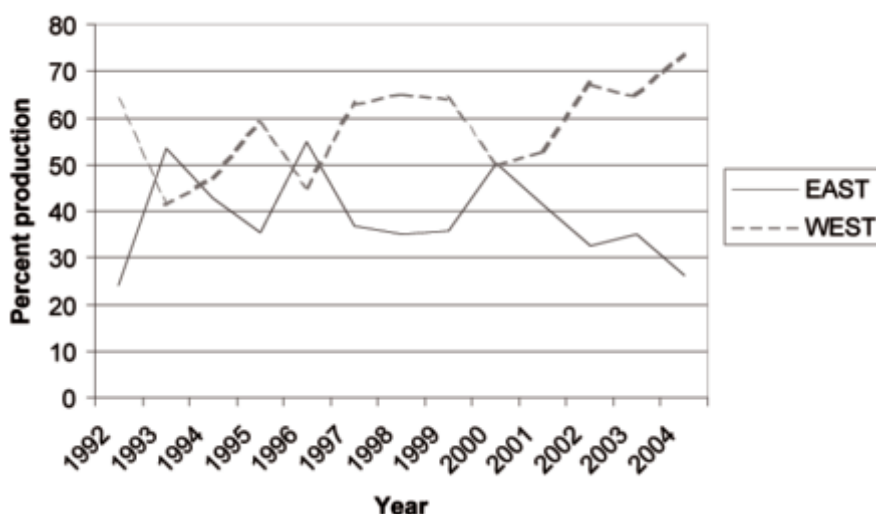


Fig. 9. Comparison of pecan production between states east and west of the Mississippi River from 1992 through 2004.

forages, so he took an educated gamble and chose blueberries. It was a new crop with no other ARS location in the South working on it.

This proved to be a prudent decision.

In 1976 the facility officially became the USDA Small Fruits Research Station. Cultural

practices, including fertilization recommendations, and pest management systems for the Gulf Coast area were developed. Seven blueberry cultivars that were adapted specifically to the Gulf States Region were selected at this station. Also, several blueberry and strawberry cultivars adapted to wider growing regions were cooperatively released.

Support from growers also grew as research proved to be a valuable asset to enhance the growing blueberry industry in the Gulf States. Increase in research funding by the U.S. Congress in the last 30 years has helped to expand blueberry research to include areas such as entomology, postharvest physiology, and plant breeding. The small fruit research staff has grown from one research scientist to six. Since the first publication in 1974, this station has published more than 1,000 articles on blueberries and other small fruit.

Ornamental production has experienced rapid growth over the past 20 years in the Gulf Coast region and nationally (Census of Agriculture 1987, 1992, 1997, 2002) (Fig. 5). Ornamental growers in the Gulf States felt their industry would be more prosperous if additional support for research could be provided. When the groups became aware of the central location and core horticultural expertise of the USDA-ARS Small Fruit Research Station, various industry groups petitioned Congress for funding for ornamental research at the Poplarville location and funding was secured in 2000 to expand the research focus. In 2002, funding was granted for the construction of a new horticultural laboratory building. Currently, six USDA-ARS scientists are employed to research various aspects of ornamental plant production and genetics. Shortly after Katrina, the name of the Poplarville facility was changed to the Thad Cochran Southern Horticultural Laboratory (Fig. 6) and scientists moved into the new research facility. Several scientists from Mississippi State University also share the laboratories.

Economic Impact of Katrina on Ornamental and Blueberry Production

The cropping cycle for ornamental crop production is generally much shorter than that for other perennial crops, such as fruits and nuts. Thus, producers can recover from natural disaster and generate income sooner. The industry, however, is dependent on production infrastructure such as greenhouse and shade house structures, which are often decimated by hurricanes.

Within weeks after Hurricane Katrina the Mississippi Nursery and Landscape Association (MNLA) reported that the green industry incurred significant losses: entire garden centers were blown away, roofs of greenhouses collapsed, and due to loss of power, irrigation systems were inoperable, causing significant crop injury. MNLA and Mississippi State University estimated that, MS nursery producers' losses ranged from \$17 to \$19 million.

In 1992, Hurricane Andrew tested the strength of the ornamental industry in Dade County, Florida. The storm damaged or destroyed about 1,300 acres of shade houses

and greenhouses, and 4,000 acres of woody ornamental nursery crops (Hull and Hodges, 1993). The loss of plant inventories estimated at \$162,000 was the most important impact of Hurricane Andrew to nurseries (Hodges, 1992). Hull and Hodges (1993) have presented a detailed account of not only the direct impact of Hurricane Andrew on the economy of the area, but also the indirect impact including time value of lost sales, costs for replanting crops, and costs for replacement of fixed capitals, that totaled \$206 million. They concluded, "The experience of Andrew showed that contingency plans are important for a business in case of natural disaster. For nursery operations, plans should include provisions for temporary employee housing, food, and water, because employee's needs for security and survival for themselves and their families must be met first. Finally, the occasion of a disaster is an opportunity for nursery managers to carefully assess their long-term business strategy. In many ways, it is a chance to start anew, to do things differently..." It is expected the ornamental industry damaged by Katrina in Alabama, Mississippi and Louisiana will go through the same phases of recovery.

Rabbiteye blueberry (*Vaccinium ashei* Reade) production has increased from 12 to 810 commercial hectares in Mississippi during the interval between hurricanes Camille and Katrina. Rabbiteye production acreage in the southeastern U.S. (Alabama, Georgia, Florida, Mississippi, Louisiana, and Texas) is growing steadily along with the national blueberry acreage. Regional blueberry acreage has increased from 1533 ha in 1987 to 3633 ha in 2002. Blueberry acreage in the southeastern U.S. remains at about 17% of the national acreage for domesticated blueberries (Census of Agriculture 1987, 1992, 1997, 2002) (Fig. 7). The blueberry industry is now thriving and growing each year and will probably show few long-term effects of recent hurricane damage.

The current directive for the Southern Horticultural Laboratory is to develop improved production methods for small fruits and ornamentals in the Gulf states.

Production trends of the last four agricultural censuses indicate that both commodity groupings are experiencing steady moderate increases for the region. Katrina may produce some temporary interruptions in production but no drastic restructuring of the type experienced with tung production after Camille, is indicated.

Economic Impact of Katrina on Other Horticultural Crops

Will recent hurricanes such as Ivan and Katrina affect any horticultural crops to the extent that Camille impacted tung production? The pecan industry appears to be the most likely candidate. Since 1900, >30 severe hurricanes have tracked across the two major pecan production regions centered in southern Georgia and in eastern Texas adversely affecting production (Pielke and Landsea, 1998). Hurricane Camille (1969), Frederic (1979), and Opal (1995) have decimated pecan production in Mississippi and

Alabama over the last 40 years and crop acreage has not kept pace with national trends (Census of Agriculture 1987, 1992, 1997, 2002) (Fig. 8). These powerful storms have eradicated many orchards and shifted production centers in these states away from Southern counties. Intense damage to these same production areas, as well as the Florida panhandle and Louisiana by Ivan in 2004, and Katrina in 2005, may eliminate commercial pecan production in areas impacted by these hurricanes. South Carolina producers did not replant many pecan trees damaged by Hurricane Hugo in 1989 because economic factors discouraged replanting (Reighard et al., 2001). These same economic forces may persuade producers from Florida to Louisiana to make the same decision.

Production trends indicate that pecan production is shifting away from the Gulf States to the Southwest and Mexico (Census of Agriculture 1987, 1992, 1997, 2002) (Fig. 9). Costs associated with hurricane damage are a component of other economic factors that are responsible for the shift. Pecan orchards are expensive to establish, requiring major investments over several years before the first crop is harvested. Recovering from damages inflicted by hurricanes is often equivalent to establishing an orchard in terms of years without income. The likelihood of exposure to hurricane force winds several times during the life of an orchard indicates that orchard management should include strategies that reduce damage and hasten recovery. With proper preventative cultural practices and aggressive recovery measures, the crop can survive hurricane damage (Wood et al., 2001), but other economic factors may not justify the additional expense.

Managers of horticultural enterprises have historically maintained more independence from federal programs than other sectors of agriculture. Federal crop insurance is available for many horticultural crops and should be considered a necessary tool to maintain the economic viability of operations continuously threatened by catastrophic events (Crane, 2005). The costs of insurance should be internalized by growers as part of annual production costs. The self-sufficient free-enterprise philosophy of American horticulture does not generally establish strong channels of communication with federal agencies responsible for assisting agriculture producers after natural disasters. The time to foster communication is before natural disasters occur rather than during times of stress. Horticulturists also need to maintain strong involvement with commodity groups that strengthen communication with legislators and government agencies.

Blueberries, ornamentals and pecans are just a few of the horticultural crops grown in the Gulf Coast region. Hurricane impact on horticultural production in the region varies with the crop. Crops that mature in the spring and early summer or that recover quickly from damage will rapidly resume normal production. For crops that are slow to recover or that are not competitive economically, it is an opportunity to try something new.

One phrase heard over and over again after

Hurricane Katrina had destroyed so much was "I didn't think it was going to be this bad." Through all of the journal and news articles that have been reviewed preparing this paper, there is a hindsight wisdom saying "Prepare Now". Hurricanes are inevitable for the Gulf Coast region. It is not a matter of IF a hurricane will hit, but WHEN the hurricane will hit. The only sure way to prevent hurricane damage to a crop is to plant it somewhere else. If that is not an option, wise planning and implementation of measures to minimize crop damage will determine economic success. "An ounce of preparation is worth a pound of cure" paraphrases an oft quoted proverb which was probably authored after a disaster such as Hurricane Katrina.

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