

Water Quality/Quantity

**Best Management Practices
for**

Florida Sod



2008 Edition

TABLE OF CONTENTS

COMMISSIONER LETTER.....	ii
ACKNOWLEDGEMENTS.....	iii
INTRODUCTION.....	1
BMP EVALUATION AND IMPLEMENTATION	3
General Information.....	3
BMP Identification and Selection.....	3
Additional BMP Requirements.....	3
Required Documentation	4
BMP Effectiveness Summary	4
BMP Needs Assessment	5
GENERAL INFORMATION FOR ENVIRONMENTAL PROTECTION ON SOD FARMS	9
Agronomic and Turf Species Issues	10
Nutrient Management for Sod	12
Irrigation and Water Resources Management.....	17
Pest and Pesticide Management.....	22
BEST MANAGEMENT PRACTICES FOR SOD FARMS.....	27
1.0 Nutrient Management	29
2.0 Irrigation Scheduling	33
3.0 Irrigation System Maintenance and Evaluation.....	35
4.0 Sediment and Erosion Control Measures.....	37
5.0 Integrated Pest Management.....	41
6.0 Wellhead Protection	43
7.0 Wetlands and Springs Protection	45
8.0 Ditch Construction and Maintenance.....	47
9.0 Conservation Buffers	49
10.0 Stormwater Management.....	51
11.0 Access Roads.....	53
12.0 Mowing Management	55
13.0 Seasonal Farming Operations.....	57
APPENDICES.....	59
Appendix 1. Additional BMP References	60
Appendix 2. Contact Information.....	62
Appendix 3. Glossary	64
Appendix 4. Soil and Tissue Testing Information	65
Appendix 5. Incentive Programs for Qualifying Farms.....	67
Appendix 6. Example Record Keeping Forms	69
Appendix 7. Notice of Intent to Implement Form and BMP Checklist	71



FLORIDA DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES

COMMISSIONER ADAM H. PUTNAM

COMMENTS BY COMMISSIONER ADAM H. PUTNAM

Dear Agricultural Producers:

This manual, *Water Quality/Quantity Best Management Practices for Florida Sod*, reflects the hard work of representatives of the industry; federal, state, and local government; and other stakeholders. In general, agricultural lands maintain valuable water recharge areas and preserve open spaces. The BMPs in this manual address water quality and quantity impacts from production activities and help maintain the environmental advantages of keeping the land in agriculture.

While best management practices have been in place for many years in our state, their role in environmental protection was formally established in 1999 with the passage of the Florida Watershed Restoration Act. This legislation provides the framework for implementing Florida's Total Maximum Daily Load program, which sets water quality targets for impaired waters. It also identifies best management practices implementation as the means for agriculture to help meet those targets.

As Florida's population continues to increase, there are more impacts to and competition for Florida's limited water resources. All Floridians must take part in conserving and protecting these resources. This manual represents the industry's commitment to do just that.

As a native Floridian whose family has long been involved in agriculture, I want to thank all who participated with the Department in the development of this important manual. With the active support and participation of so many dedicated people, I am optimistic about the future of Florida's agricultural industry. I trust that you will join me in supporting this valuable water resource protection effort.

Sincerely,

A handwritten signature in black ink, appearing to read "Adam H. Putnam".

Adam H. Putnam
Commissioner of Agriculture

ACKNOWLEDGEMENTS

A Steering Committee was established in 2005 to guide the development of BMPs and the overall structure of this BMP manual. Additionally, a technical working group was formed to support the efforts of the Steering Committee, and this group was charged with developing and reviewing specific BMPs associated within their area of expertise. It should be noted that an effort of this magnitude could not have been accomplished without the tireless dedication of all participants. The following is a list of individuals who participated in the development of this manual. Each of these individuals and their organizations made important contributions to the process, and their work is sincerely appreciated.

Steering Committee

Bill Bartnick – Florida Department of
Agriculture and Consumer
Services

Erin Boyd – Sod Solutions, Inc.

Dave Dymond – H & H Sod

Mark Garrett – Kirkland Sod

Paul Grose – King-Ranch

Brittany Mayock – Florida Department of
Agriculture and Consumer
Services

Betsy McGill – Florida Sod Growers
Cooperative

Dr. Mike Thomas – Florida Department of
Environmental Protection

Keith Truenow – Lake Jem Farms

Working Group

Dr. Eileen Buss – University of Florida-IFAS

Dr. John Cisar – University of Florida-IFAS

Bill Donovan – South Florida Water
Management District

Mark Luchte – Southwest Florida Water
Management District

Ross Morton – Southwest Florida Water
Management District

Will Nugent – Bethel Farms

Dr. Jerry Sartain – University of Florida-IFAS

Vince Singleton – St. Johns River Water
Management District

Dr. Laurie Trenholm – University of Florida-IFAS

Dr. Bryan Unruh – University of Florida-IFAS

Additional Industry Contributors

Rex Cunningham – Environmental Turf

Stan Speed – Lykes Bros., Inc.

Co-Editors

Bill Bartnick – Florida Department of
Agriculture and Consumer
Services

Dr. Brian Boman – University of Florida - IFAS

Dale Calhoun – Florida Department
of Agriculture and Consumer
Services

Betsy McGill – Florida Sod Growers
Cooperative

Dr. Mike Thomas – Florida Department of
Environmental Protection

This publication was funded in part by the Florida Department of Environmental Protection with a Section 319 Nonpoint Source Management Program Grant from the U.S. Environmental Protection Agency.


DISCLAIMER

The mention of a specific product or company is for information purposes only and does not constitute an endorsement of that product or company.

INTRODUCTION

Florida's sod growers contribute approximately \$300 million to the state's economy, and can positively impact the environment as well. In fact, scientific research has documented the many benefits of modern turfgrass production to our environment. Sod farm fields and associated home lawns release oxygen to the atmosphere, help to significantly cool surrounding surface temperatures, naturally filter pollutants from runoff water, reduce soil erosion, purify and replenish our water supply, and provide other aesthetic or recreational values. The industry is proud of these attributes and remains committed to fostering water resources protection through the implementation of BMPs.

Things to keep in mind as you use this manual are:

- Italicized words that appear in red are defined in the Glossary, and specific recordkeeping requirements are noted using a "pencil mark" icon. 
- Remember to fill out the BMP Manual Registration Card inside the front cover and return it to the Florida Department of Agriculture in order to receive future updates to this manual.

General Applicability of this Manual

The practices outlined in the manual are intended to be applied statewide by sod growers, regardless of the variety or species grown. This manual does not apply to golf courses, home lawns, athletic fields, or other recreational facilities. This manual can be downloaded from the internet at: www.floridaagwaterpolicy.com.

BMP History and Purpose

With the passage of the Federal Clean Water Act (FCWA) in 1972, states were required to assess the impact of nonpoint sources of pollution on surface and ground waters, and establish programs to minimize them. Florida's Nonpoint Source Management Program was established in 1978 and has undergone numerous changes over the years. The program includes the use of structural and nonstructural BMPs to minimize nonpoint source pollution, either through traditional regulations (i.e., Environmental Resource Permits) or through other voluntary measures (i.e., implementation of BMPs).

Section 303(d) of the FCWA also requires states to identify impaired water bodies and establish total maximum daily loads (TMDLs) for pollutants entering these water bodies. TMDLs establish the maximum

amount of pollutants that can be discharged to a water body and still have it meet its designated uses such as swimming, fishing, or as a potable water use. To address TMDLs, the Florida legislature passed the 1999 Florida Watershed Restoration Act (FWRA). Under the Act, once the Florida Department of Environmental Protection (FDEP) establishes a TMDL, an implementation plan may be developed that specifies the activities that watershed landowners and other stakeholders will undertake to reduce point and nonpoint source pollutant loadings. Many of Florida's 44,000 commercial farmers who produce food, fiber, and livestock on approximately 10 million acres will be required to meet specific pollutant load allocations. The FWRA gives the Florida Department of Agriculture and Consumer Services (FDACS) the authority to develop interim measures, BMPs, cost-share incentives, and other technical assistance programs to assist agriculture in reducing pollutant loads in target watersheds. The law also stipulates that the FDEP must verify that these BMPs are effective at reducing pollutant loading to waters.

BMPs are a practice or combination of practices determined by the coordinating agencies, based on research, field-testing, and expert review, to be the most effective and practicable on-location means for improving water quality. BMPs are typically implemented as a *treatment train*. This normally includes a combination of nonstructural and structural practices which have been determined to be effective for reducing or preventing pollution. BMPs must be: technically feasible, economically viable, socially acceptable, and based on sound science.

Implementation of BMPs will generally lead to:

- A better managed operation where management has an enhanced awareness of the cost and efficiency of production
- An improved public image (environmental stewardship) to capitalize on global business opportunities

Pursuant to sections 403.067(7)(c), and 570.085, F.S., implementation, in accordance with FDACS rule, of FDEP-verified and FDACS-adopted BMPs gives ranchers the following advantages:

- A presumption of compliance with state water quality standards
- A release from the provisions of s.376.307(5), F.S., for those pollutants addressed by the BMPs
- Assistance with BMP implementation

Statutorily Exempt Agricultural Activities

Under subsection 373.406(2), F.S., any person engaged in the occupation of agriculture may alter the topography of any tract of land for purposes consistent with the practice of agriculture. These activities may not be for the sole or predominant purpose of impounding or obstructing surface waters. As such, agricultural activities that meet these criteria may qualify for a statutory exemption from an Environmental Resource Permit (ERP).

Pursuant to 373.406(9), F.S., environmental restoration activities on agricultural lands that have minimal or insignificant impacts to water resources may also be exempt from an ERP, provided that written notification is received beforehand.

Even if the two exemptions above apply, these provisions do not relieve agricultural producers from implementing BMPs or conducting monitoring if they are located within a watershed with an adopted BMAP.

Also, persons engaged in the occupation of agriculture have protections under the Florida Right to Farm Act (section 823.14, F.S.). The Act states, with certain exceptions, that no farm which has been in operation for one year or more and was not a nuisance at the time of its established date of operation shall be a public or private nuisance, if the farm operation conforms to generally accepted agricultural and management practices.

BMP EVALUATION AND IMPLEMENTATION

General Information

Florida law defines a process for the development of TMDLs by FDEP for impaired waters and authorizes FDACS to identify and adopt appropriate agricultural BMPs by rule once FDEP has verified that these BMPs are effective at reducing pollutant loading. Participating growers then benefit by receiving a “presumption of compliance” with state water quality standards, and are eligible to apply for cost-share monies to implement selected BMPs.

If the proper implementation of BMPs does not meet water quality targets, then FDACS will be required to revise or develop additional BMPs over time.

BMP Identification and Selection

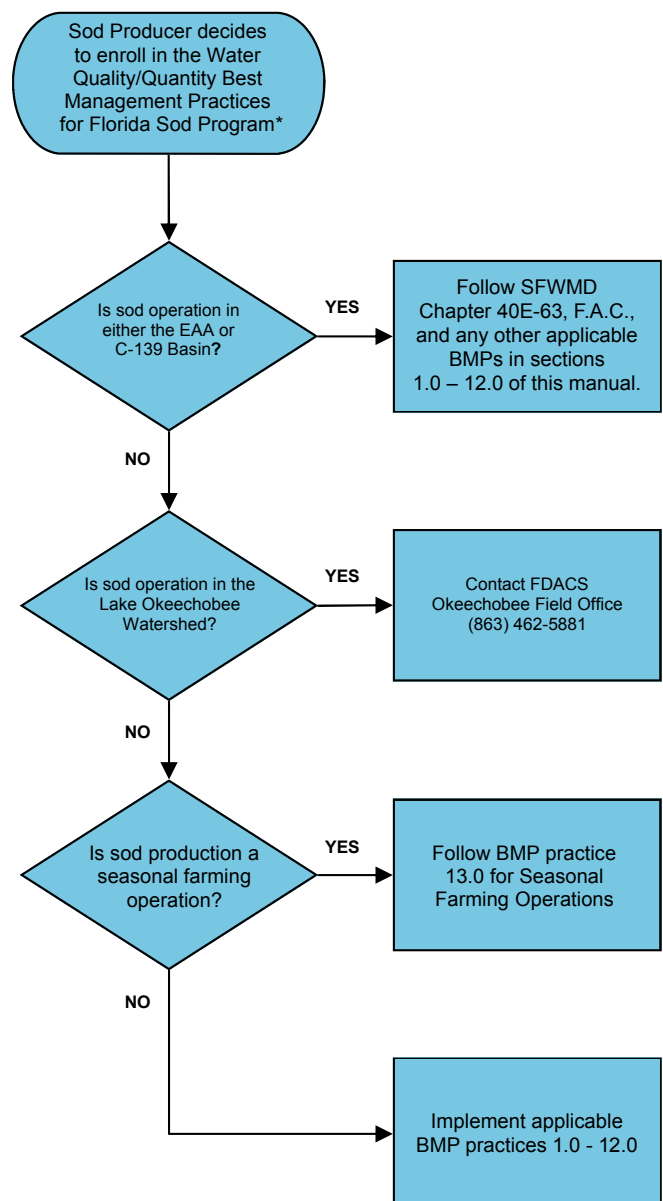
Selecting BMPs for multiple sod species in different production regions is a difficult process. In general, it involves the following steps:

1. Choose the applicable practices from the set of BMPs for sod farms and implement them within the first 12 months.
2. Use the BMP Decision-Tree which identifies additional BMP requirements for specific circumstances.
3. Request on-farm technical assistance, as needed.

Sod growers shall implement the applicable BMPs in the “Best Management Practices for Sod Farms” chapter to establish a foundation for environmental protection. The goal of the BMPs is to reduce agricultural pollutants discharged offsite and to provide an equivalent level of waste treatment applied to other facilities other than agriculture. Depending on your farm’s site specific conditions or geographical location, all of the BMPs may not need to be implemented. In addition, growers must also use the **BMP Decision-Tree** to help accurately identify other BMPs that are applicable to their farming operation. This tool identifies more specific BMP requirements that may apply in certain cases. For instance, growers who are temporary or seasonal sod farming operations may have fewer BMPs; while those who farm in springs recharge basins and/or special regulatory areas (i.e., EAA), may have additional BMPs that apply. Finally, sod growers should avail themselves of **On-farm assistance** when available. This will help them identify all appropriate BMPs for implementation. FDACS Ag-Team, UF-IFAS BMP Implementation Team and/or UF-IFAS Extension staff are available to assist growers with the mechanics of BMP identification and selection.

Additional BMP Requirements


As mentioned in the preceding section, growers should use the BMP Decision-Tree to help accurately select all BMPs applicable to their farming operation. This tool is intended to be used like a standard flow chart, in that users start at the top and work their way through all “decision steps” until an endpoint is reached. The flow chart addresses special considerations that may apply to your operation. Once completed, growers should also use the Sod Production BMP Checklist which is in the appendix of this manual. This checklist will provide growers with a complete list of BMPs that will be submitted to FDACS with the Notice of Intent form mentioned below.



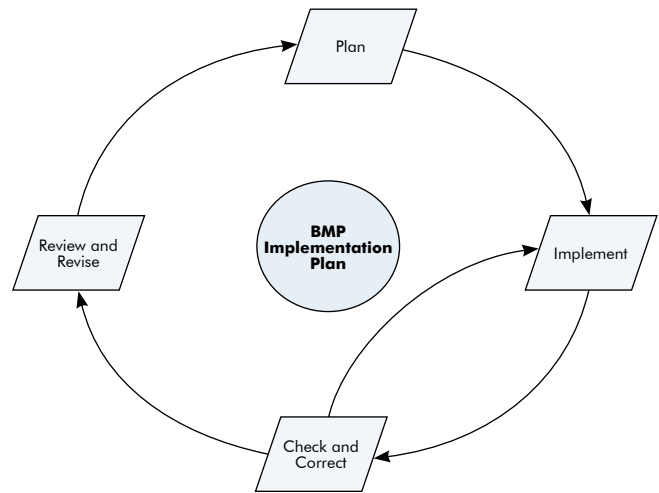
* Note: If operation is in an area where a BMAP has been adopted, producer must implement BMPs or monitor water quality. Contact FDACS Field Office for more guidance.

Required Documentation

The first key documentation item is the Notice of Intent to Implement form which contains a checklist of BMPs being or to be implemented. The form is in the appendix of this manual. Once received by FDACS, the Notice of Intent enrolls your operation in the BMP program.

BMPs generally require some level of recordkeeping. When required, growers should keep accurate written records and retain them for at least five (5) years. Fertilizer application and rainfall amounts are two examples of recordkeeping. Other recordkeeping requirements are highlighted in this manual using this figure: . A simple recordkeeping form can be used to assist you in this endeavor. FDACS has co-located field staff positions in all five water management districts to assist growers and to verify that BMPs are being properly implemented, operated and maintained as part of a quality assurance program. A quality assurance program is very important to ensure that BMP implementation is occurring on track and that meaningful water quality improvements are being made in affected basins. It also provides overall program credibility and additional assurance that BMPs are constructed and installed as designed in accordance with the Notice of Intent submittal.

It is advisable to consolidate all of your BMP decision-making, including the BMP Checklist, into a simple implementation plan. These plans then become the basis for other important management decisions associated with BMPs, including operation and maintenance activities. A well thought-out, written plan enables managers and owners to schedule their activities and accomplish their objectives.



BMP Effectiveness Summary

The table below has been developed to give sod growers an awareness of how good a particular type of BMP is at reducing various types of pollutants from leaving their fields. This table was developed using existing literature values and agency best professional judgment in order to establish the anticipated impact on water quality and quantity. The BMPs are arranged in the order which they appear in this manual, and the primary resource protection categories are Nutrients, Erosion and Water Conservation. There is also a profitability column to give users a sense of economic effects associated with the BMP. The rating system defines practices as *high*, *medium* and *low* in terms of how effective the BMP is in reducing a potential pollutant. Profitability is either *positive* or *neutral* for all BMPs and is adapted from USDA-NRCS documents. The assumptions made as a part of this table are based on the fact that each practice is applied independently of others.

BMP Category	Resource Protection Categories			Profitability
	Nutrients	Erosion	Water Conservation	
Nutrient Management	H	L	--	Positive
Irrigation Scheduling	H	H	H	Positive
Irrigation System Maintenance & Evaluation	M	L	M	Neutral
Sediment & Erosion Control Measures	M	H	M	Positive
Integrated Pest Management	L	--	M	Positive
Well Head Protection	H	--	--	Neutral
Wetlands and Springs Protection	M	M	M	Positive
Ditch Construction & Maintenance	L	M	M	Positive
Conservation Buffers	M	H	M	Positive
Flood Protection	L	M	--	Neutral
Access Roads	--	M	--	Positive
Mowing Management	L	L	M	Neutral
Seasonal Farming	M	M	M	Positive

-- denotes little to no effect

BMP NEEDS ASSESSMENT

The following assessment questions are designed to assist growers in choosing the appropriate BMPs for implementation on their farms. The results of this assessment should be kept in mind when reading *BMPs for Sod Farms* in this manual and completing the *BMP Checklist* located in the appendix.

The questions below are arranged by BMP category. Based on your responses, if you need more information about a BMP category, please read the related text in this manual under *General Information for Environmental Protection on Sod Farms*. This text provides important background about BMPs and directs you to reference materials for more information. Additional references are contained in *BMPs for Sod Farms*, at the end of each BMP category section.

It is important to remember that agricultural BMPs evolve over time, and it is critical that growers stay current with the latest information and technology.

Instructions:

- Answer “Yes”, “No” or “S/W” in the space provided after each question. S/W stands for somewhat, and should be used if you are only somewhat familiar with the content.
- As needed, read *General Information for Environmental Protection on Sod Farms*, and consult the applicable references listed there and in the relevant sections under *BMPs for Sod Farms*.
- Retain this BMP Needs Assessment for your use – You do not need to submit it with the Notice of Intent to Implement that you submit to enroll your farm with FDACS.

1.0 NUTRIENT MANAGEMENT

- ☐ Y ☐ N ☐ S/W Are you familiar with the relationship between soil type and water quality?
- ☐ Y ☐ N ☐ S/W Have you conducted a soil survey to determine your soil type(s) and identify the environmentally sensitive areas on your farm?
- ☐ Y ☐ N ☐ S/W Are you familiar with the procedures and benefits of soil and tissue testing and how to use the results?
- ☐ Y ☐ N ☐ S/W Are you aware of the effects of pH on the availability of nutrients?
- ☐ Y ☐ N ☐ S/W Are you familiar with IFAS recommended crop nutrition requirements for N and P and other essential nutrients?

- ☐ Y ☐ N ☐ S/W Do you manage nutrients carefully in coarse, sandy soils and address the special needs of managing P on *uncoated sands*?
- ☐ Y ☐ N ☐ S/W Are you familiar with the benefits of splitting soluble fertilizer applications or using controlled release fertilizers during field establishment or in sensitive areas?
- ☐ Y ☐ N ☐ S/W Have you considered the effects of heavy rains after making soluble fertilizer applications? Are you familiar with the guidelines for supplemental applications after leaching rains?
- ☐ Y ☐ N ☐ S/W Are you familiar with the use of fertigation and when it should be used?
- ☐ Y ☐ N ☐ S/W If reclaimed water, manure, or biosolids are used on your operation do you adjust your fertilizer applications accordingly?

2.0 IRRIGATION SCHEDULING

- ☐ Y ☐ N ☐ S/W Have you determined your field’s available soil moisture content and how to maintain the field within the recommended range?
- ☐ Y ☐ N ☐ S/W Do you understand how soil moisture devices are used, tested, and calibrated?
- ☐ Y ☐ N ☐ S/W Are you familiar with how to calculate your rainfall contribution and use evapotranspiration levels to guide irrigation decisions?
- ☐ Y ☐ N ☐ S/W Do you use water meters or other methods to determine how much irrigation is being applied during applications?
- ☐ Y ☐ N ☐ S/W Are you aware of the importance of not exceeding the amount of irrigation that can be stored in the root zone?
- ☐ Y ☐ N ☐ S/W Are you familiar with methods to minimize irrigation losses, such as irrigating in the morning, afternoon, or when cloud cover is abundant and wind speed is minimal?
- ☐ Y ☐ N ☐ S/W Do you take into consideration how the maturity level of the sod affects irrigation needs?

3.0 IRRIGATION SYSTEM MAINTENANCE AND EVALUATION

- (Y) (N) (S/W) Are you familiar with the procedures for testing your irrigation system for maximum efficiency?
- (Y) (N) (S/W) Do you understand the importance of maintaining irrigation uniformity throughout the field?
- (Y) (N) (S/W) Are you familiar with preventative maintenance procedures and how to develop a preventative maintenance plan for your irrigation system, including periodic inspection and replacement of broken sprinkler nozzles?
- (Y) (N) (S/W) Have you considered sampling your irrigation water quality annually?
- (Y) (N) (S/W) Do you understand the importance of water control structures, maintaining the land level, and keeping ditches and canals free of debris and vegetation?

4.0 SEDIMENT AND EROSION CONTROL MEASURES

- (Y) (N) (S/W) Are you planning to convert native lands to new sod fields, or construct new canals or ditches?
- (Y) (N) (S/W) Have silt screens been constructed to standards referenced in the Florida Stormwater, Erosion, and Sediment Control Inspector's Manual?
- (Y) (N) (S/W) Have you considered using filter strips and/or flashboard water control structures to aid in the reduction of erosion?
- (Y) (N) (S/W) Are erosion problems severe enough to warrant the installation of sediment traps, sediment basins, or the use of chemical soil amendments?

5.0 INTEGRATED PEST MANAGEMENT

- (Y) (N) (S/W) Have your key pests been identified by qualified scouts?
- (Y) (N) (S/W) Do you know what preventative practices to use and when to minimize pest re-emergence?
- (Y) (N) (S/W) Do you understand the benefits of using lower toxicity chemicals and periodically switching pesticide products to delay pest resistance problems?
- (Y) (N) (S/W) Have you considered using portable

mix-load stations throughout the field to reduce potential contamination?

- (Y) (N) (S/W) Are all empty pesticide containers rinsed and disposed of properly?

6.0 WELLHEAD PROTECTION

- (Y) (N) (S/W) Have you properly inventoried all existing water wells and assessed their vulnerability to contamination? Have all abandoned or artesian wells been properly plugged or capped?
- (Y) (N) (S/W) Will all new wells be constructed by a licensed Florida water well contractor and located up gradient, away from pollutants such as fuel tanks, chemical mixing areas, and septic tanks?

7.0 WETLANDS AND SPRINGS PROTECTION

- (Y) (N) (S/W) Have you properly inventoried all wetlands, springs, and sinks within your farm boundaries using a soil survey or other mapping tools?
- (Y) (N) (S/W) Are you familiar with the use of buffers between farm fields and watercourses or wetlands to reduce potential adverse impacts?
- (Y) (N) (S/W) Have you considered the benefits of using filter strips, buffers, swales, or on-site ponds to provide additional treatment sources?
- (Y) (N) (S/W) Have you considered routinely using controlled release fertilizer within areas that drain directly to wetlands, springs, or wet-sinks?

8.0 DITCH CONSTRUCTION AND MAINTENANCE

- (Y) (N) (S/W) Did you research topographic maps, soil survey maps, seasonal high water table limitations, and/or natural drainage outlets before constructing your ditch system?
- (Y) (N) (S/W) Have you considered the use of lateral ditches to provide additional drainage?
- (Y) (N) (S/W) Are sediments routinely cleaned from ditches and do ditch banks have vegetative cover, to maintain proper function?
- (Y) (N) (S/W) Have you considered using basic survey techniques to record the ditch cross-sectional area? This can be a beneficial record for future maintenance.

9.0 CONSERVATION BUFFERS

- ☐ Y ☐ N ☐ S/W Does the farm have a field border that can be used as a turn row for equipment? Does the border also function as a diversion feature to redirect concentrated water flows?
- ☐ Y ☐ N ☐ S/W Have you considered creating riparian buffers on fields that have more than a 1% slope?
- ☐ Y ☐ N ☐ S/W Have you explored whether conservation buffers may be eligible for cost-share by federal or state agencies?

10.0 STORMWATER MANAGEMENT

- ☐ Y ☐ N ☐ S/W Have you experienced recurring flooding problems on your farm? If so, have you evaluated the natural and/or manmade features on your farm to determine what drainage features may be needed or added?
- ☐ Y ☐ N ☐ S/W Have you explored whether any FEMA floodplain maps exist for your location?
- ☐ Y ☐ N ☐ S/W Have you discussed your decisions with an engineer to back-up your decision?

11.0 ACCESS ROADS

- ☐ Y ☐ N ☐ S/W Are you contemplating constructing any new roads within the farm boundaries? If so, are you able to maintain a 25-foot setback from wetlands?
- ☐ Y ☐ N ☐ S/W Are you planning to construct your road using porous materials to minimize runoff?
- ☐ Y ☐ N ☐ S/W Can you ensure that road construction can be completed before the rainy season begins?
- ☐ Y ☐ N ☐ S/W Do road shoulders or grassed waterways have a gentle slope and/or vegetation to prevent erosion?
- ☐ Y ☐ N ☐ S/W Do any elevated roads impede the natural flow of surface water?

12.0 MOWING MANAGEMENT

- ☐ Y ☐ N ☐ S/W Do you mow at a frequency that allows you to maintain optimum plant health?
- ☐ Y ☐ N ☐ S/W If clippings are removed are they disposed of using environmentally acceptable practices?

13.0 SEASONAL FARMING OPERATIONS

- ☐ Y ☐ N ☐ S/W Do you harvest sod on a three-year rotation and maintain vegetative cover during fallow periods?
- ☐ Y ☐ N ☐ S/W Have you determined the carbon-to-nitrogen ratio of any residual material incorporated into the soil, and do you understand its implications?
- ☐ Y ☐ N ☐ S/W Are you aware of the need to maintain appropriate wetland setbacks to protect water quality?

General Information for Environmental Protection on Sod Farms

AGRONOMIC AND TURF SPECIES ISSUES

Agronomic Issues

Before a new sod field can be established the ground must be properly prepared. In general, land preparation activities include tilling, leveling, liming, and fumigation. However, other actions may be needed depending on the land's use prior to sod production.

Tillage can be accomplished with a moldboard or chisel plow to break up any hardpan layers. A depth of up to ten inches may be necessary, and will give the sod more air and water movement and deeper rooting. Rocks and stumps should be removed from the field as well. Growers using sub-surface irrigation may not need to till deeper than the hardpan in order to facilitate capillary action. This, of course, depends upon the turf variety and the need to develop an extensive root system.

Leveling is necessary to achieve uniform cutting during harvesting. Leveling also facilitates drainage and uniform water distribution to sod fields. A laser plane may be used for the most precise leveling.

Liming can be used to adjust the pH of the field and to supply essential nutrients like calcium and magnesium if they are naturally deficient in soils. Calclitic and dolomitic limes are two of the more commonly used liming materials. Except for the flatwoods areas of Florida which are generally acidic, most organic soils are near neutral pH, so a pH test should be performed before lime is added. Also factor in that different sod species have different pH requirements. Bahiagrass and centipedegrass should not be limed if it would create a soil pH greater than 6.0.

Preplant fumigation will help eliminate pernicious weeds before the initial sod planting. This is especially necessary if the field had been used for pasture in the past. Methyl bromide fumigation is being phased out, but other chemicals can be used.

Species Issues

Sod species selection and planting is largely determined by the local market. Beyond the market's influence, there are several reasons why different species should be considered for your operation based on a number of factors specific to your location. Soil type, tolerance to pests, drought, climate, and maintenance level are all factors to consider when starting a new field. The species most com-

monly grown for commercial sod production in Florida include St. Augustinegrass, centipedegrass, bahiagrass, bermudagrass, and zoysiagrass. As mentioned, your location within the state and the demands of the local market are most often what influences what will be grown, but the following general information about the more common species can help a grower make a sound business decision and grow sod in an environmentally compatible fashion.

St. Augustine species are usually started from sod or plugs. They can be grown anywhere in the state on a wide range of soil types. Most species are given a moderate rating for maintenance, but irrigation and pest control needs vary by species. It is recommended that St. Augustinegrass be fertilized every 6 to 8 weeks during the growing season with the caution that too much nitrogen (greater than 50 lbs N/acre per application) can promote chinch bug infestation and grey leaf-spot disease. St. Augustinegrass is popular for lawns in much of Florida, and some of its species are shade tolerant.

Centipedegrass is known for its low maintenance properties, and therefore is popular for home lawns and businesses. It will grow on most soils including acidic types, and in general is fertilized less often than other sod species. Fertilization at low rates of nitrogen should be used to prevent thatch buildup and general turf decline, and the application of potassium should be used to encourage rooting during the fall.

Bahiagrass is generally grown from seed for use on lawns and roadside right-of-ways. Like centipedegrass, it will grow on acidic soils and is very low maintenance. It is drought tolerant and has little trouble with pests, with one exception being mole crickets. Bahiagrass is fertilized on a schedule similar to centipedegrass, but is not likely to have similar rooting and thatch problems.

Bermudagrass has a fine blade, excellent wear tolerance, and is most commonly used for golf courses and athletic fields. It must be mowed often and responds to frequent fertilization for optimal growth. Bermudagrass is not shade tolerant and can be susceptible to pests and disease so vigilance is necessary. It is fairly drought tolerant.

Zoysiagrass grows in slowly and is most often started from sod or plugs but some seeded varieties are also available. It can be grown anywhere in

the state, and is usually used for lawns and golf courses. Some varieties can require moderate to high maintenance with their fertilization schedule and pest control needs, but zoysiagrass is prized for its appearance and drought and wear tolerances. Empire zoysiagrass, a popular variety, is known for its ability to grow in the hot humid climate of Florida more rapidly than some of the slower growing zoysia species. It also typically requires less maintenance than other species.

Seashore paspalum is a species known for thriving along the coasts where salinity can be a problem

for most grasses. It is usually started from sod or sprigs, and once its roots are established it will spread quickly by both rhizomes and stolons. Seashore paspalum has a fine-medium blade, and currently is used mostly for athletic fields and golf courses.

The table below summarizes some of the species described above. More information is found throughout this manual concerning the specific needs of these species. Also, please be aware that other species of sod are grown in Florida but these are the most common and widely demanded.

Comparison of Common Sod Species Grown in Florida

	St. Augustinegrass	Centipedegrass	Bermudagrass	Bahiagrass	Zoysiagrass	Seashore Paspalum
Recommended Soil pH	6.0-7.5	5.0-6.0	5.0-7.0	5.0-6.0	5.5-7.0	4.0-9.8
Texture	Coarse-Med	Medium	Med-Fine	Coarse-Med	Med-Fine	Coarse-Fine
Tolerance to:						
Drought	Good	Good	Excellent	Excellent	Excellent	Excellent
Shade	Good (species dependent)	Fair	Poor	Fair	Good	Poor
Wear	Poor	Poor	Excellent	Fair	Excellent	Excellent
Mowing Height (in.)	2-4 (species dependent)	1-2	0.5-1	3	0.5-2 (species dependent)	0.5-2
Mowing Frequency (days)	7	10	3	7	10	3-5
Maintenance Level	Moderate	Low	High	Low	Moderate-High	Moderate-High
Major Use	Lawns	Lawns	Golf courses, athletic fields	Lawns, roadsides	Lawns/golf courses	Lawns/golf courses

NUTRIENT MANAGEMENT FOR SOD

General Fertilization Principles

Proper fertilization for sod production normally reflects the need for grass growth and re-growth following establishment or cutting of the prior crop. Nitrogen (N) is the most important nutrient for this response. Generally, higher rates and frequencies of nitrogen application reduce the production time for a crop; however, excessive nitrogen rates force excessive top growth at the expense of the roots, thus reducing the “liftability” of the sod. Economics also dictate, to an extent, the amount and frequency of nitrogen use. A balance needs to be maintained between all major and minor elements since the unavailability of any nutrient may affect other plant processes. Environmental concerns also need to be carefully weighed, since applying macronutrients such as nitrogen and phosphorus in excess of plant nutrient uptake can cause *eutrophication* of nearby water bodies. The result may be low dissolved oxygen levels which negatively affect aquatic organisms. Therefore, sod managers should conduct soil tests before planting and yearly thereafter to monitor pH and nutrient levels, and should remain cognizant of the needs of the particular grass being grown.

Some of Florida’s soils naturally provide adequate phosphorous and near neutral soil pH levels. On the other hand, some of the sandier, highly leached soils may not contain adequate phosphorus levels to support optimum plant growth. Given these variables, growers need to use soil and/or tissue testing to determine what fertilizer formulations are appropriate for their site. Growers commonly use fertilizer materials that contain both nitrogen and phosphorous sources. These, along with potassium (K), are the most prevalent macronutrients. Examples of such fertilizer sources include di-ammonium phosphate or mono-ammonium phosphate. In general, phosphorous and liming materials (if necessary) are applied prior to planting, and nitrogen is applied during the growing season in multiple or split applications. Phosphorous is also commonly available as concentrated super phosphate or triple super phosphate. A fertilizer with a nitrogen:potassium ratio of 1:1 or 2:1 is generally recommended to increase the turf’s stress tolerance level and to promote better rooting. Subsequent fertilizer applications are often made following the second mowing, with continued applications made based on observation, experience and/or tissue testing until the grass develops into a complete ground cover.

Fertilization practices must also be considered in conjunction with soil pH. The optimum soil pH for St. Augustinegrass, bermudagrass, and zoysiagrass is approximately 6.0 to 6.5. Centipedegrass and bahiagrass have an optimum soil pH of 5.0 to 6.0. Near neutral soil pH levels help to facilitate cation exchange in soils and minimize potential leaching or mobility of certain cation nutrients such as ammonium which is a positively charged molecule. Developing a basic understanding of the chemical and colloidal properties of your soil type will make you a better environmental steward.

Macronutrients

The three macronutrients most relevant to plant growth are N, P, and K. Sod uses significantly less P than N and/or K. Responses to P fertilization are most typically observed during establishment, rooting development and seed head production, especially in soils that have a P deficiency. Because P has been implicated as a cause of increased algae and noxious weed growth in surface waters, proper P fertilization management is imperative. Therefore, the goal in P management should be to apply the correct amount based on soil and tissue testing results.

Nitrogen, which is important for plant protein synthesis and vegetative growth, has the potential to be leached to groundwater by rainfall or over-irrigation on sandy soils, and may move laterally into surface waters. Under proper application, sod will use most of the available nitrogen. The rate of nutrient application, particularly N, depends on a number of factors: soil type, sod species, the location in the state where the sod is being grown, time of year, and type of fertilizer source being used (soluble or controlled-release). Thus, a single annual rate of N application is not recommended, rather split applications are key. Nitrogen is often applied in a water soluble form such as urea, ammonium nitrate or ammonium sulfate. Leaching losses can be minimized by making frequent, low-rate applications of soluble fertilizers, using controlled-release nitrogen sources, or applying a combination of the two fertilizer materials. Low-rate applications are usually made using soluble fertilizers, whether applied as a liquid during fertigation or as a granular product. To limit the environmental impact of your fertilization program, it is recommended that no more than 50 pounds of

soluble N per acre be applied in a normal application, and less when root coverage is incomplete.

Of the three primary nutrients, K is second only to N in utilization by sod. Large responses in sod growth are not typically observed in response to K fertilization, and proper K nutrition has been linked to reduced disease incidence, increased drought and cold tolerance, and enhanced root growth. The K fertilization rate is often tied to the N fertilization level, generally in a 2:1 or 1:1 ratio. Ideally, sod K fertilization should be based on soil test recommendations. Because of its high mobility in sandy soils, K fertilization should be made as soon after soil testing as possible. Fortunately, K is not considered a pollutant, but prudent application of K fertilization is essential for economic and resource conservation reasons. Excessive K fertilization can contribute to high soil electrical conductivity (EC) levels that may limit root growth and sod tolerance to drought. Keep in mind that K is considered to be a soluble salt constituent, and combined with other "salts" such as sodium and chloride ions can result in plant toxicity effects.

For a detailed fertilization guide for Florida sod, see IFAS Publication SL-52, *Fertility Considerations for Sod Production*, at: <http://edis.ifas.ufl.edu/SS164>

Micronutrients

Most soil testing laboratories usually analyze and make recommendations for copper (Cu), manganese (Mn), and zinc (Zn). Of these three micronutrients, sod responses have only been observed for Mn. In most Florida soils, extractable Cu and Zn levels are adequate for optimum sod growth, except for Cu in organic soils. No analysis or recommendation is made for Fe in Florida soils due to limited information on the correlation between soil and tissue levels, and sod growth response. A greening in response to the application of Fe and/or Mn will most likely be obtained on sod grown on soils having a pH of 7.0 or greater or on sod irrigated with alkaline water. The application of iron sulfate as a foliar spray usually produces the desired response. This response is generally short-lived, however, and reapplication may be required. Sod growers are well-advised to eliminate a micronutrient deficiency first, before simply applying excessive amounts of N in order to overcome a problem. Doing this out of "habit" without the benefit of understanding the entire nutrient picture will lead to increased nutrient-related impacts of water resources.

Sod Fertilization Management

One of the first steps in developing a sound sod fertilization management program involves a basic knowledge of the soils on which the sod is being grown. This knowledge can be acquired by observing and evaluating the soil's physical and chemical properties. Most Florida soils are sands and therefore retain limited quantities of water and nutrients. Individuals with only limited training in soils can discern whether a soil is mostly sand or predominately clay, and whether the soil contains flakes of free calcium carbonate or shell. The "feel and appearance method" has been promoted for years by the USDA-Natural Resources Conservation Service, and it can also be used to estimate soil moisture levels. Keep in mind that soil properties may significantly affect a sod fertilization management program.

Chemical properties such as soil pH, lime requirement, extractable levels of phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and selected micronutrients such as manganese (Mn), copper (Cu), and zinc (Zn) can be determined through proper soil and tissue testing. Florida soils are not analyzed for nitrogen (N) because this element is highly mobile in sandy soils. Since reliable correlations between turfgrass growth and soil test N have not been developed, sod N fertilization is based on scientific research results for the turfgrass species being grown.

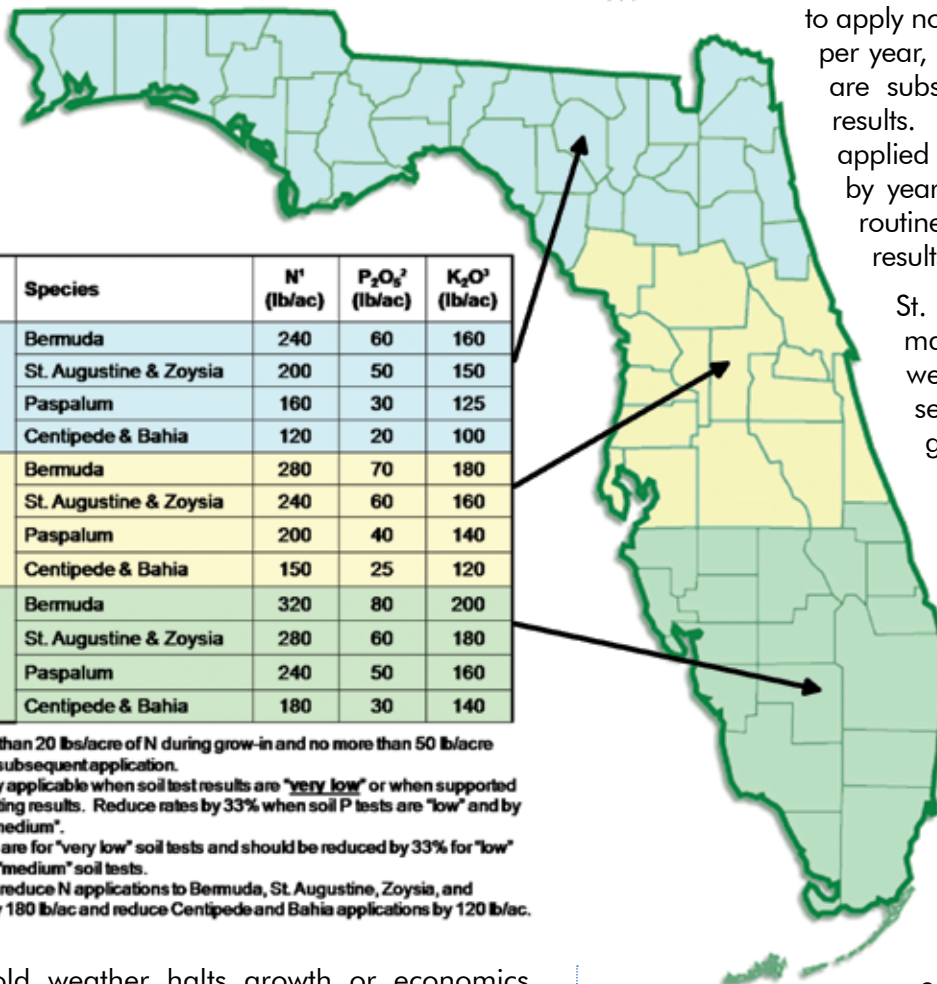
Scheduling and Rates

One of the most important principles of fertilization timing is avoiding fertilizer application to dormant or non-growing turfgrass. During dormancy, turfgrasses take up very small quantities of nutrients, and applied nutrients are much more likely to leach. Slow-release sources also influence the timing of fertilization, in that fertilization is required less frequently. In either case, do not apply fertilizer when heavy rains are imminent.

Once the sod has grown into a full cover, fertilizer scheduling is largely dictated by economics. Obviously, if sod orders are strong, the grass needs to be actively fertilized to minimize production time. Conversely, if sales are slow, sod should be fertilized less to save on fertilizer and maintenance costs such as mowing and watering. Bermudagrass and zoysiagrass respond exceptionally well to fertilization. Once full cover is achieved, quickest turn-around of these grasses generally occurs with fertilization at the equivalent rate of 50 lbs N/acre per application. This schedule should continue

Fertilization Guidelines for Florida Sod Production

(adapted from: J. B Sartain. 2007. Fertility Considerations for Sod Production. Univ. of Florida, IFAS. Exten. Fact Sheet SL-52. 9 pp)



¹Apply no more than 20 lbs/acre of N during grow-in and no more than 50 lb/acre during each subsequent application.

²P rates are only applicable when soil test results are "very low" or when supported by tissue testing results. Reduce rates by 33% when soil P tests are "low" and by 66% when "medium".

³K rates in table are for "very low" soil tests and should be reduced by 33% for "low" and 66% for "medium" soil tests.

⁴On muck soils, reduce N applications to Bermuda, St. Augustine, Zoysia, and Paspalum by 180 lb/ac and reduce Centipede and Bahia applications by 120 lb/ac.

unless cold weather halts growth or economics dictate otherwise.

During re-establishment from ribbons, the volume of roots in a field can vary by species. Therefore, fertilization during this period should be reduced to account for the limited root mass. Incrementally increase fertilizer application rates in proportion to increased rooting as the stolons and/or rhizomes grow. Precision application equipment can be used to apply variable rates of fertilizer, or to apply a banded fertilizer application to the ribbon area only. The equipment may be controlled remotely, either via global positioning units that utilize geographical information systems technology, or by electronic sensors mounted on the equipment. Growers should take note that applying nitrogen fertilizer at the rate of 20 lbs/acre to 40% of the area along the ribbon is equivalent to broadcasting 50 lbs/acre. The same concentration of nitrogen will be available in the root zone. Precision application equipment cost-share reimbursement programs may available in some parts of the state, so check into this first. Also, a 2:1 or 1:1 ratio of nitrogen to potassium fertilizer should be used with each application to

encourage strong rooting. In general, depending on species, sod growers are encouraged to apply no more than 300 lbs N/acre per year, unless additional quantities are substantiated by tissue testing results. Phosphorus should be applied only when recommended by yearly soil test results or more routine tissue testing analysis if the results indicate the need.

St. Augustinegrass is normally fertilized every 6 to 8 weeks during the growing season. As with bermudagrass and zoysiagrass, St. Augustinegrass should be fertilized with a 2:1 or 1:1 ratio of nitrogen to potassium fertilizer and phosphorus added as suggested by soil test results. If over-fertilized in summer with a soluble or quickly available nitrogen source, St. Augustinegrass can become more susceptible to chinch bug infestation and grey leaf-spot disease. The best defenses against these problems are

small, frequent applications of nitrogen. Additionally, these problems can be minimized by using controlled-release nitrogen sources and supplemental iron applications.

Bahiagrass and centipedegrass are generally fertilized less than the other sod species. Bahiagrass is sometimes fertilized yearly with 100 to 200 lbs N/acre, but may be fertilized more for higher maintenance turf production settings; however, to avoid environmental problems, no more than 50 pounds of soluble N per acre should be applied in a normal application, assuming full cover is present. Again, economics and desired sod turn-around time dictate which rate range is to be used. Two applications per year are acceptable if 100 pounds of 50 percent slow release nitrogen is used and equally divided between early spring (April-May) and summer (July-August).

Centipedegrass has a very specific fertilization schedule. If over-fertilized long-term with nitrogen, centipedegrass will develop thatch, decreased winter

survival and reduced rooting. The end result, referred to as “centipedegrass decline,” is characterized as death or extremely weak spots that develop as the grass resumes growth in spring. Normally, centipedegrass decline does not develop until several years after establishment. Established centipedegrass should be fertilized only 2 to 3 times per year, with an average of 25 to 50 lbs N/acre per application. In North Florida, an additional 45 lbs K/acre should be considered in early fall to encourage proper rooting prior to winter. Remember that all sod species have a specific crop nutrient requirement and that fertilization practices beyond this range will typically be lost to the environment, thus increasing the risk of water and air pollution.



Soil Probe

Zoysiagrass and Bermudagrass respond quickly to proper fertilization. The recommended rate is 50 lbs N/acre per application once the sod is fully established, and less during the ribbon grow-out period. Nitrogen application should also be cut back during winter dormancy and when economics dictates. Strong rooting is encouraged by a 2:1 or 1:1 ratio of nitrogen to potassium fertilizer. Soil testing should indicate if phosphorus is needed.

Soil Testing and Interpretation

Soil testing is an applied science and can be used as one of the tools in the maintenance of healthy sod production. Proper fertilization recommendations and minimizing the nonpoint source pollution risk are the hallmarks of a routine soil testing program. For the effective management of nutrients, soil testing should be used in conjunction with tissue testing. Soil test recommendations are based on a correlation between the level of a given nutrient extracted from the soil and the anticipated plant response. The amount of nutrients extracted by a particular extractant is only an index relative to crop response. It is not a direct measure of actual plant nutrient availability. The levels of extracted P, K, and Mg are divided into five categories: very low, low, medium, high, and very high. For more information, see your county Cooperative Extension Service agent or IFAS Publication SL-181, *Soil Testing and Interpretation for Florida Turfgrasses*, at: <http://edis.ifas.ufl.edu/SS317>.

A soil analysis supplies a wealth of information on

the nutritional status of a soil and can detect potential problems that limit plant growth. To reiterate, a routine soil analysis supplies information on soil pH and the extractable P, K, Ca, and Mg status of the soil. The University of Florida Soils Lab in Gainesville currently uses Mehlich-1 as an extractant on all the acidic mineral soils and AB-DTPA (Ammonium Bicarbonate-DTPA) extractant on soils with pH above 7.3 (calcareous soils).

The table below presents general interpretation ranges for soil test levels of P, K, Mg, Mn, Zn, and Cu.

Suggested ranges for Mehlich-1 extractable soil nutrient levels for turfgrasses

Macronutrients* (ppm)			Micronutrients** (ppm)		
P	K	Mg	Mn	Zn	Cu
16-30	36-60	20-30	3-9	0.5-3	0.1-0.5
* Medium ranges of Mehlich-1 extractable P, K, and Mg when in 25 percent of the cases a response to applied fertilization would be expected.					
** Soils testing below these levels of micronutrients are expected to respond to applied micronutrients. The interpretation of soil test micronutrient levels is based on soil pH. The smaller number is for soils with a pH of less than 6.0, and the larger number is for soils with a pH of 7.0 or greater. Mehlich-1 extractable micronutrient levels are only determined when requested and require an additional charge.					

Tissue Testing

Because of the mobility of most essential nutrients in soils, one of the best indicators of appropriate fertilization and plant health is tissue analysis. Since sod is a perennial crop, historical logs of tissue composition can be used to fine-tune a sod fertilization program for optimum plant growth and minimum environmental impact. Leaf analysis, along with sod appearance and soil analysis, can be used to diagnose the effectiveness of a fertilization program, especially for micronutrient deficiencies. Soil analysis for some nutrients - because it is a snapshot of what is present at the time of sampling - does not always indicate their availability to plants. Potential nutrient deficiencies can be detected with leaf analysis before visual symptoms appear. Also, leaf analysis may provide information on induced deficiencies and inferences on plant uptake.

Sufficiency ranges of tissue N concentration for selected turfgrasses

Grass	N (%)
St. Augustine	2.0 - 3.0
Zoysia	2.0 - 3.0
Bermuda	2.5 - 3.5
Centipede	1.5 - 2.5
Bahia	1.5 - 2.5
Rye	3.5 - 5.5

Sufficiency levels of essential nutrients in the various sod species do not vary much among the various species, except for N. The sufficiency of tissue N concentration can vary from a low of 1.5 percent for centipedegrass or bahiagrass to a high of 3.5 percent in cool-season, overseeded ryegrass. The table above contains a list of the sufficiency ranges for tissue N concentration for the various turfgrasses. In most cases, tissue N concentrations below the minimum of the range would be deficient and above the range would be excessive.

The concentration of other macro and micronutrients in the tissue does not vary greatly among the various species of sod. The sufficiency ranges listed in the table below are applicable to most of Florida's sod species. All of these values are on a dry weight basis. These values represent the range over which a particular nutrient might vary across the various species of sod. They represent sufficiency ranges, which suggest that levels below the range may indicate a deficiency or above the range may represent excessive fertilization or toxicity.

Sufficiency concentration ranges for selected macro and micronutrients in turfgrass tissue

Parameter	Range	Units
P	0.15 - 0.50	%
K	1.0 - 3.0	%
Ca	0.5 - 1.0	%
Mg	0.2 - 0.5	%
Fe	50 - 250	ppm
Cu	5 - 30	ppm
Mn	25 - 100	ppm
Zn	20 - 250	ppm
B	5 - 20	ppm

Water Supply

Proper water management planning must consider all uses of water, ranging from the source of irrigation water to a plant's water use requirements. It is very important to differentiate between crop water requirements and irrigation water requirements. Crop water requirements refer to the actual water needs for *evapotranspiration* (ET) and plant growth, and primarily depend on crop-specific development and climatic factors. Irrigation water requirements are primarily determined by soil storage capacity and crop water requirements, but also depend on the characteristics of the irrigation system. It is extremely important that the irrigation system is designed properly so that the crop will get the right amount of water when it needs it the most. This will help maximize both crop yield and profit, while preventing wasteful water application.

Water taken from a reliable source and delivered to a crop via an irrigation system is known as water supply. With the exception of South Florida, most of the irrigation water used in Florida agriculture is withdrawn from underground, aquifer sources. Regardless of the source's origin, it is important to know the quantity and quality of the water source before designing and installing an irrigation system. This is particularly important if you intend to use a sprinkler type system. Water quality analyses are performed at a number of private and public labs and can provide valuable clues to determine the potential for irrigation plugging problems, fertigation compatibility, and/or salinity trends. Settling ponds or basins may be used to remove large inorganic particles and can also be used for aeration of groundwater containing high amounts of iron or manganese.

It is important to ensure that the water source does not become contaminated. Florida law requires backflow prevention assemblies on all irrigation systems injecting chemicals into irrigation water. For detailed information on these requirements, refer to IFAS Extension Bulletin 258, *Causes and Prevention of Emitter Plugging in Microirrigation Systems* which can be found at: <http://edis.ifas.ufl.edu/AE032>. Appropriate backflow prevention should include a check valve upstream from the injection device to prevent backward flow; a low-pressure drain to prevent seepage past the check valve; a vacuum relief valve to ensure that a siphon cannot develop; and, a check valve on the injection line.

Water management districts are responsible for projecting future water demand over a twenty-year time period for each major water use category. Where demand is expected to exceed available supplies, the districts develop regional water supply plans that identify water sources and water resource development projects sufficient to meet the expected needs. An effective water supply planning process is especially important to agriculture as they are typically "self-suppliers" of all water used on the farm. *Florida's Agricultural Water Policy Document (July 2003)* contains more details on water supply and planning and can be found at: www.floridaagwaterpolicy.com.

Irrigation System Design and Installation

Irrigation system design is a complex issue and should be handled by trained professionals. These professionals use existing standards and criteria, as well as manufacturers' recommendations, to design the most appropriate system for a location.

The irrigation design for a site depends on a number of factors, including location, soils, vegetation, water supply, and water quality. An irrigation system needs to be designed to meet a site's peak water requirements. However, it should also be flexible enough to adapt to various water demands and local restrictions. The two main types of irrigation systems are surface irrigation, which involves channeling water through canals and ditches to raise or lower the water table, and pressurized systems, such as sprinklers.

An irrigation system consists of four main components:

1. Water supply -- this consists of a water source, pumps, filters, and valves (including backflow valves), and, for surface irrigation, water gates and level controls
2. Water conveyance -- in surface systems, these are canals and main ditches. Pressurized systems generally include a mainline, manifold, lateral lines, and isolation valves
3. Distribution devices -- these include center pivots, lateral movers, traveling guns, and solid set systems. Field ditches are used to distribute water in surface water irrigation systems

4. **Control system** – these may be manual or automatic and can be locally or remotely controlled, and may include float switches, computerized control systems, weather stations, soil moisture sensors, etc.

The design must account for different site characteristics and topographies. Adequate pressure (head) is important for irrigation systems to function properly. The design operating pressure must not exceed the available source pressure or the capacity of the water supply. The irrigation design should also account for any additional water that may be periodically needed to leach salt buildup caused by poor-quality irrigation water.

In pressurized systems, backflow prevention devices are needed to protect the water source from contamination. Water conveyance systems should be designed with thrust blocks and air release valves to prevent system damage. Water conveyance pipelines should provide the appropriate pressure required for maximum irrigation uniformity. Distribution devices should be designed for optimum uniform coverage and must have precipitation rates that do not exceed the ability of the soil to absorb and retain the water applied during any one application.

Surface systems may be able to use gravity feed from the water source, or water may need to be pumped into a reservoir to provide adequate head. Tailwater recovery systems should also be considered to recover runoff from the site to be pumped back into the irrigation system for beneficial reuse. The proper design and installation of the components listed above optimizes their efficiency and decreases any off-site impacts.

Irrigation System Operation

Plants don't waste water, people do. Using proper irrigation system design, installation, water management, and maintenance practices provides a multitude of benefits. An efficient irrigation system translates into cost savings and protection of Florida's water resources.

Irrigation management is the cornerstone of water conservation and reduced nutrient and pesticide movement. It includes both scheduling the amount and frequency of water applied and the maintenance of system components, both preventive and corrective. Irrigation scheduling must take plant water requirements and soil moisture capacity into account to prevent excess irrigation water that could lead to leaching and runoff. Plant water

needs are determined by evapotranspiration rates, recent rainfall, recent temperature extremes, and soil moisture. Whenever possible, cultural practices should be used to minimize plant stress and the amount of water needed. For example, sod growers can use mowing, nutrition, and other cultural practices to control water loss and to encourage conservation.

Irrigation Scheduling

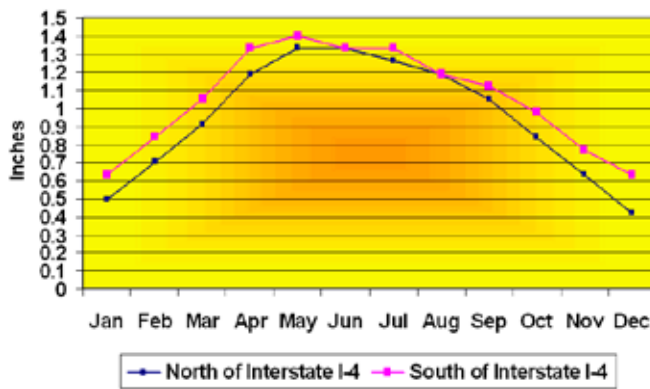
Before a grower can properly develop an irrigation schedule, the system must be audited, or calibrated, so that the rate at which water is applied to each field is known. Once the water delivery rate is known, determining when and how much to water is the next important step. Irrigation should not occur on a calendar-based schedule but should be based on ET rates (see chart on next page) and soil moisture replacement. Rain gauges are necessary measurement tools to track how much rain has fallen throughout the farm. The use of soil moisture probes, inspections for visual symptoms such as wilting turf, computer models, and tensiometers will enhance the efficiency of an irrigation scheduling program.

Water loss rates decrease with reduced solar radiation, minimal wind, high relative humidity, and low air temperatures. A grower can take advantage of these factors by irrigating when conditions do not favor excessive evaporation. Irrigation should occur in the early morning hours before air temperatures rise and relative humidity drops. Irrigating at this time also removes dew from leaf blades and allows sufficient time for infiltration into the soil but does not encourage disease development.

Determining how much water to apply is the next step in water management. Enough water should be applied to wet the entire root zone. Wetting below the root zone is generally inefficient and promotes leaching. Also, irrigating too often encourages shallow rooting, increases soil compaction, and favors pest outbreaks. For sod, the majority of roots are in the top 4 to 6 inches of soil. Soil moisture estimates can be determined by using a soil probe to feel the depth of moisture and show the depth of the root zone.

It is important to keep in mind that, while new technology makes many tasks easier or less labor intensive, it is the principles discussed in this BMP manual that are important. These principles may be applied to any farm at almost any level of technology.

Potential evapotranspiration (ETp) levels
for two regions of Florida



Irrigation System Maintenance

Irrigation system maintenance on a sod farm involves four major efforts: calibration or auditing, preventive maintenance, corrective maintenance, and recordkeeping. Maintenance is necessary on any irrigation system, whether it be center pivot, linear sprinkler irrigation, or seepage irrigation. Uniformity of water application, efficiency, water conservation, and reduction of operation and maintenance costs are some of the benefits of a regular maintenance program. The overall goal is to maximize system performance. Maintenance programs vary according to the type of irrigation system. In general, all sod farms should follow a regular, well documented, maintenance routine.

If an irrigation system is in disrepair or coverage is obviously poor, then time is wasted doing a detailed audit. A visual inspection should first be conducted to identify any necessary repairs or corrective actions, and it is essential to make any repairs before carrying out other levels of evaluation. A visual inspection should be part of ongoing maintenance procedures.

In many areas of the state, Mobile Irrigation Labs are available to perform these audits at no charge. If such service is available, free audits are recommended. After the audit is complete, implement all repairs needed to improve distribution uniformity and adjust the irrigation schedule as needed based on the lab's recommendation.

Detailed information on calibrating an irrigation system is provided in the Florida Irrigation Society's *Urban Irrigation Auditor Certification Manual* (2002). Copies of the manual may be obtained by calling FIS at 1-800-441-5341.

Personnel charged with maintaining any irrigation system face numerous challenges. This is particularly true for those with older or outdated equip-

ment. Good system management starts with good preventive maintenance procedures and record-keeping. Maintaining a system is more than just fixing heads. It also includes documenting system and maintenance-related details so that potential problems can be addressed before expensive repairs are needed. It also provides a basis for evaluating renovation or replacement options.

Maintenance of flood or seepage systems includes operational checks of pump stations and structures, including cleaning and maintaining all ditches. It is important to maintain optimum pressure ranges for pump station equipment. Water control structures like risers and culverts should be kept clean and operational to assist with water conservation. Maintenance programs for pressurized pipe systems (center pivot, lateral moves and traveling guns) generally involve filtration, chlorination/acidification, flushing, repair or replacement of clogged emitters, and observation. Nozzles need to be replaced when worn out, and replacements should have the same flow and pressure characteristics as the original design.

Visual Inspection Elements

With the system on, inspect for the following:

- Mainline breaks,
- Low pressure at the pump,
- Head to head spacing,
- Interference with water distribution,
- Broken heads,
- Misaligned heads,
- Rain sensor present and functioning,
- Backflow device in place and in good repair,
- Turf quality and plant health for indications of irrigation malfunction or need for scheduling adjustments, and
- Make adjustments and repairs on items diagnosed during the visual inspection before conducting pressure and flow procedures

In summary, the benefits of maintaining your irrigation system in good condition include uniform sod growth, water conservation, and reduced operation and maintenance costs. For more information on this topic, refer to the *Irrigation System Maintenance and Evaluation BMP* in this manual.

Stormwater Management

Stormwater is defined as the runoff from impervious surfaces and water-saturated surfaces, trans-

porting sediments and dissolved chemicals into nearby waters. This runoff can be a major cause of nonpoint source pollution which negatively affects Florida's rivers, streams, and springs often leading to problems from turbidity and eutrophication. Clippings, fertilizers, and pesticides can also contribute to stormwater runoff problems on a sod operation.

There are many mechanisms for stormwater treatment and control. A BMP "train" approach yields excellent results and is often the preferred method. In this approach, water is conveyed from one treatment practice to another by conveyances which also contribute to the treatment process. For example, runoff can be directed across a vegetated filter strip into a wet detention pond, and then through a swale into a constructed or natural wetland. Vegetative buffers and swales are excellent sources of sediment and pesticide filtration.

The best solution to stormwater runoff is to prevent it in the first place. Land should be kept vegetated as much as possible to hold soil in place. When land is left uncovered, which is the case during establishment of a new sod field, sedimentation barriers like silt screens should be employed. The banks of canals and ditches should be kept planted to hold soil in place. This helps to maintain the integrity of the bank side-slope thus preventing unnecessary erosion. Low maintenance vegetation is the best choice for vegetative buffers. Usually, these buffers do not need to be mowed or fertilized, as this practice may compound stormwater runoff issues. To prevent the movement of fertilizers and pesticides into water bodies, "no spray" zones should be established within a set distance of the water. Application should never be conducted right up to the water line, unless allowed by the label.

Another solution to stormwater runoff can be to develop a tailwater recovery system. This system can conserve water and improve water quality by collecting and re-using irrigation water or rainfall that runs off the surface of sod fields. A tailwater recovery system should be located at the low end of a field(s), so that water collection can be done by gravity. Capacity of tailwater recovery systems shall be determined by analysis of the expected runoff rate, the planned storage pond capacity, and the irrigation application rate(s) if the recovery pond is to supply irrigation water. The stored tailwater should be analyzed for nutrient content and then adjust the sod's fertigation program accordingly. Unfortunately, the water collected from fields may also contain disease-causing fungal spores and

bacteria. Dilute tailwater earmarked for reuse with fresh water to lower disease concentrations if this is of concern.

Permitting Considerations

Florida's five water management districts have the primary regulatory authority for issuing well construction, water use and surface water permits for agriculture. Well construction permits, which are sometimes delegated and issued by county governments, are required prior to the drilling, construction and/or repair of a well. These permits ensure that wells are constructed by qualified, licensed contractors to meet safety, durability and resource protection standards. A water use permit allows the user to withdraw a specified amount of water, either from a groundwater well or from a surface water source. Statewide, Florida agriculture uses approximately 50 percent of all permitted freshwater withdrawals, and this figure is expected to remain relatively constant for the next twenty years. In general, before a user can receive a new permit to withdraw water, the permit applicant must establish that the proposed water use satisfies a three-prong test in Section 373.223, F.S., which requires:

- The proposed use is reasonable and beneficial;
- The proposed use will not interfere with any existing legal use of water; and,
- The proposed use is consistent with the public interest.

Almost all users who withdraw water from wells or surface water bodies require a water use permit. Whether the required permit is a general water use permit issued by rule or an individual water use permit issued by the Water Management District Governing Board or staff depends upon the location and the annual average daily allocation requested. Generally, permits are issued from ten to twenty years depending upon the specific technical circumstances that prevail. These circumstances focus on items such as subsurface drawdown impacts, saltwater intrusion, and/or wetland hydrology impacts. Water use permits are important because they provide growers with a legal right or "instrument" to use the water for supplemental irrigation purposes and other related agricultural uses (e.g., livestock watering, frost protection, crop cooling, etc.). All permits have conditions placed upon them, and may also have specific reporting requirements. Pumping reports are usually required on some frequency, especially if the use is in a Water Resource Caution Area.

An Environmental Resource Permit is sometimes required for agriculture, especially if the activity affects wetlands, alters surface water flows, or contributes significantly to water quality pollution. These permits are fairly complicated, and require engineering analyses to demonstrate that the proposed design meets all permitting criteria.

Lastly, the water management districts have special drought/water shortage restrictions that govern the amount and timing of irrigation. It is important to know the water shortage category and type of restrictions for your farm; although, many agricultural users on low volume irrigation systems are exempt from these restrictions.

Besides water, growers need to be aware of other permitting issues. Petroleum storage tanks may require registration and, if so, must meet FDEP rule criteria for secondary containment. Growers should also be aware of all potential on-site waste streams, including spent solvents and degreasers, as these may be classified as hazardous wastes and require FDEP permitting for the proper storage and disposal of the used material.

PEST AND PESTICIDE MANAGEMENT

Pesticide Use

Pesticides are designed to kill or alter the behavior of pests. If they are not used wisely, pesticides may pose health risks to pesticide applicators and others, and may create long-term environmental problems. There are many facets to pesticide use: targeting problem pests, inventory and storage of pesticide product, mixing and loading of pesticides for application, handling spills, properly calibrating application equipment, licensing requirements of applicators, applying the product at the labeled rate, staying abreast of worker safety issues and performing key recordkeeping functions.

A pest-control strategy should be used only when the pest is causing or is expected to cause more damage than what can be reasonably and economically tolerated. A control strategy should be implemented that reduces the pest numbers to an acceptable level while minimizing harm to non-targeted organisms. The strategy of Integrated Pest Management or IPM centers on prevention (keeping a pest from becoming a problem) and suppression (reducing pest numbers or damage to an acceptable level).

It's important to balance pesticide efficacy with environmental, health and safety issues. The most obvious method to reduce risk from pesticides is to use them only when necessary. Growers must determine which pesticides are the most useful and least environmentally harmful for a given situation. Apply them properly and effectively to minimize costs and the effects on public health and the environment while maintaining plant health. Give particular attention to the vulnerability of the site to groundwater or surface water contamination from leaching or runoff. Lastly, always follow the directions on the label. These directions have been developed after extensive research and field studies on the chemistry, biological effects, and environmental fate of the pesticide. The label is the single most important document in the correct use of a pesticide, and state and federal pesticide laws require strict adherence to label directions. For more specific information on pesticide use for sod producers, please refer to the IPM BMP in this manual.

Sod Pests

Weeds

Unchecked weeds compete with turfgrass for space, water, light and nutrients, and can harbor insect pests and diseases. The predominant weed species change from season to season in Florida. Because weed populations can explode if not kept in check, the amount of pressure from these pest plants remains consistently high.

Weeds reproduce from seed, root pieces, and special vegetative reproductive organs such as tubers, corms, rhizomes, stolons, or bulbs. Many of the weeds that show up in sod fields come from seeds. Weed control is important for good quality sod. In general, weakened turf or bare areas result from: (a) poor selection of turf species not adapted to the local environmental conditions; (b) damage from turfgrass pests such as diseases, insects, nematodes and animals; (c) improper timing of agrichemicals; (d) improper turf management practices such as improper mowing height or mowing frequency and improper soil aeration; and, (e) physical damage and compaction from excessive traffic. Unless factors which contribute to the decline of the turf are corrected, continued problems with weed encroachment can be expected. For more information, see IFAS Publication ENH-884, *Weed Management in Home Lawns* at <http://edis.ifas.ufl.edu/EP141>, or ENH-1039, *New Options for Managing Weeds in the Landscape* at: <http://edis.ifas.ufl.edu/EP296>.

Insects and Other Organisms

Less than one percent of all insects are harmful to plants and many are actually beneficial, acting as predators or parasites of harmful insects and assisting in the cross-pollination of certain plants. Remember that disease, nutritional deficiencies, cultural treatments, and environmental conditions can cause a plant to appear unhealthy or discolored, so it is important to diagnose a problem correctly before corrective measures are taken. Consider all of the control options available under IPM before using a chemical control method for an active pest infestation. Monitoring or scouting is the most important element of a successful IPM program. Scouting enables a grower to monitor pest presence and development throughout the growing season. By observing turf conditions regularly (daily, weekly, or monthly, depending on the pest) and noting which pests are present, an intelligent decision can be made regarding which pests are present,

how damaging they are, and what possible control strategy is necessary. Keep in mind that pests may be present for some time before damage occurs or is noticed. It is essential to record the results of scouting and monitoring in order to develop historical information, document patterns of pest activity, and document successes and failures.

In general, IPM calls for pesticides to be applied as needed when plants have an active infestation and significant damage is likely. However, some pest problems may be best handled with preventive measures, such as biological-control techniques, and these should be based on professional knowledge of the control agent or method, the pest's life cycle, environmental conditions, and historical data. Use preventive chemical applications only when your professional judgment indicates that properly timed, preventive applications are likely to control the target pest effectively while minimizing economic costs and environmental effects.

For more information on IPM and insect pests, go to:

- IFAS Circular 1149, *Integrated Pest Management Strategies*, at <http://edis.ifas.ufl.edu/LH080>
- IFAS Publication ENH-300, *Insect Pest Management on Turfgrass*, at <http://edis.ifas.ufl.edu/IG001>
- Featured Creatures at <http://creatures.ifas.ufl.edu>

Plant Parasitic Nematodes

Nematodes are small, unsegmented roundworms, generally transparent and colorless; most are slender, with bodies up to 1/8 inch long. Only about 10 percent of nematodes are estimated to be plant parasites. Nematodes affect plants by damaging the roots, thus reducing their ability to function.

For more information on nematodes, go to:

- IFAS Publication ENY010, *Nematode Management for Sod Production in Florida*, at <http://edis.ifas.ufl.edu/IN125>
- IFAS Fact Sheet RF-LH053, *Nematodes: What They Are, How They Live, What They Do to Turf*, at <http://edis.ifas.ufl.edu/LH053>

Plant Diseases

Plant pathology is the study of plant diseases. Diseases result in infected turfgrass and are caused by microorganisms such as fungi, bacteria, and viruses. Some disease symptoms, such as leaf spots and wilting, are easily seen or measured. Others are difficult to observe (e.g., root decay) or are very subtle (e.g., shorter growth flushes). Normally,

abiotic plant disorders are not included in the study of diseases, but it is still important to recognize them. These disorders include nutrient imbalances, temperature extremes, toxic chemicals, mechanical injury, water imbalances, and air pollution. Most environmentally induced problems tend to be more uniform, whereas disease may show up in spots and patches throughout a field.

For more information on plant disease, go to:

- IFAS Publication LH064, *Key for Identification of Landscape Turfgrass Diseases*, at <http://edis.ifas.ufl.edu/LH064>
- IFAS Publication LH040, *Turfgrass Disease Management*, at <http://edis.ifas.ufl.edu/LH040>
- IFAS publication PDMG-VG-01, *Characteristics of Plant Disease*, at <http://edis.ifas.ufl.edu/PG001>
- IFAS Rapid Turfgrass Diagnostic Service, at http://turf.ufl.edu/turf_diagnosis/index.html

Pesticide Management

Careful management of pesticide products and application to target crops is critical. Readers are encouraged to refer to the document entitled "Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance" for more specific information on pesticide BMPs. These documents can be found at www.floridaagwaterpolicy.com. Key areas of pesticide management are excerpted below to provide some basic information.

Pesticide Record Keeping and Licensure Requirements

Proper records of all pesticide applications should be kept according to state and federal requirements. These records help to establish proof of proper use, facilitate the comparison of results of different applications, or find the cause of an error. Sample record keeping forms can be found at the FDACS Bureau of Compliance Monitoring at: <http://www.flaes.org/complimonitoring/pesticidecertification.html>.

Certain pesticides are classified as restricted use pesticides (RUPs). The Florida pesticide law requires certified (licensed) applicators to keep records of all RUP use. Florida regulations require that information on RUPs be recorded within two working days of the application and maintained for two years from the application date.

Pesticide Storage

Pesticide storage areas must be properly constructed and maintained to prevent problems or an expen-

sive cleanup in the event of an accident. The best way to minimize storage problems is to minimize the amount you store. Purchase only the amount of product that you can use within a reasonable time frame. Do not store large quantities of pesticides for long periods. Adopt the “first in–first out” principle, using the oldest products first to ensure its use within the product’s shelf life. If you have to store pesticides, follow these general guidelines:

- Design and build pesticide storage structures to keep pesticides secure and isolated from the surrounding environment
- Store pesticides in a roofed concrete or metal structure with a lockable door
- Keep pesticides in a separate facility, or at least in a locked area separate from areas used to store other materials, especially fertilizers, feed, and seed
- Do not store pesticides near flammable materials, hot work (welding, grinding), or in shop areas
- Do not allow smoking in pesticide storage areas
- Store personal protective equipment (PPE) where it is easily accessible in an emergency, but not in the pesticide storage area. Remember that PPE may not provide full protection in emergency response situations.

Store pesticides in their original containers and do not put pesticides in other containers that might cause children and others to mistake them for food or drink. Keep all containers securely closed and inspect them regularly for splits, tears, breaks, or leaks. All pesticide containers should be labeled, legible, and arranged so that the labels are clearly visible.

Segregate herbicides, insecticides, and fungicides to prevent cross-contamination and minimize the potential for misapplication. Cross-contaminated pesticides often cannot be applied in accordance with the label of each of the products. This may make it necessary to dispose of the cross-contaminated materials as wastes and could require the services of a consultant and hazardous waste contractor.

Note that cancelled, suspended, or unusable pesticides must be disposed of properly. Storage for long periods can lead to leaking containers or other costly problems. The FDEP and FDACS may operate a program in your area for the free disposal of these materials (Operation Cleansweep). For more information, contact the FDACS Bureau of Compliance Monitoring at (850) 488-3314. If this program is not available, a licensed hazardous

waste disposal contractor should be contacted.

Lastly, plans and specifications for pesticide storage buildings are available from several sources, including the USDA-NRCS, the Midwest Plan Service, and the UF/IFAS Publications Office.

Mixing and Loading Activities

In most cases, the mixing and loading of pesticides into application equipment should be done adjacent to the application site. If pesticides are routinely mixed and loaded at a shop or storage site, spilled material can accumulate and expensive cleanup may be required. Instead, consider installing a permanent chemical mixing center or rotate your mix and load activities to various sites within the farm. Also, use extreme caution when handling concentrated chemicals and locate operations well away from groundwater wells and areas where runoff may carry spilled pesticides into surface waterbodies. Areas around public water supply wells should receive special consideration and may be designated as wellhead protection areas. Before mixing or loading pesticides in such areas, consult with state and local government officials to determine if special restrictions apply. Most importantly, for your own safety, always use all personal protective equipment required by the pesticide label.

Pesticide Equipment Calibration and Loading

It is critically important to keep application equipment properly calibrated and in good working order. Compliance with the pesticide label reduces the risks to applicators, workers, and the environment, saves you money, and is required by law.

Calibrate application equipment using clean water and do not calibrate equipment near wells, sinkholes, or surface waterbodies. Measure all pesticide and *diluent* materials accurately. The proper application of pesticides helps to reduce costs and increase profits. Improper application can result in wasted chemicals, marginal pest control, excessive carryover, and/or damage to sod.

Sprayers should be calibrated when first purchased or when nozzles are replaced, and then monitored as nozzles will wear which may cause the rate of flow to increase rapidly. Wettable powder formulations may accelerate nozzle tip erosion. Routine re-calibration of equipment compensates for wear in pumps, nozzles, and metering systems. Consult the operator’s manual for detailed information on a particular sprayer.

Several different calibration methods can be

found in IFAS Publication SM38, *Spray Equipment and Calibration*. It is available from IFAS at: <http://ifasbooks.ufl.edu/merchant2/merchant.mv>.

Pesticide Application Equipment Wash Water

Wash water from pesticide application equipment must be managed properly, since it may contain pesticide residues. Wash the application equipment in a designated wash area. The water hose should have an on/off valve and a water-reducing nozzle. Use the least amount of water possible to wash the equipment adequately. Spray equipment can be rinsed of pesticides residues over sod production areas when the *rinsate* will be used according to the product label. These practices prevent unwanted pesticide residues from being washed onto non-targeted areas. Avoid conducting washing operations near the vicinity of wells or surface waterbodies.

For most application equipment, the inside of the application tank should be rinsed. This is often done by using tank cleaner chemicals, filling the tank with a minimal amount of water and then applying the rinse water in the same manner and at the same site as the original pesticide. For larger equipment that is loaded at a central facility, the inside of the application equipment should be washed on the mix/load pad. This rinsate may be applied as a pesticide (preferred) or stored for use as make-up water for the next compatible application.

Pesticide Spill Management

Growers should have a spill clean-up kit available and clean up spills as soon as possible. Unmanaged spills may quickly move into surface waters and adversely affect natural systems. It is essential to be prepared for major or minor spills. The sooner you can contain, absorb, and dispose of a spill, the less chance there is that it will cause harm. Always use the appropriate personal protective equipment as indicated on the Material Safety Data Sheet and the label for a particular chemical. In addition, follow the following four steps:

- **CONTROL** actively spilling or leaking materials by setting the container upright, sealing off leak(s), or shutting the valve
- **CONTAIN** the spilled material using barriers and recognized absorbent materials
- **COLLECT** spilled material, absorbents, and leaking containers and place them in a secure, properly labeled container. Some contaminated materials could require disposal as hazardous waste

- **STORE** the containers of spilled material until they can be applied as a pesticide or appropriately disposed of

Remember to comply with all applicable federal, state, and local regulations regarding spill response training for employees, spill reporting requirements, spill containment, and cleanup procedures.

If a spill occurs for a pesticide covered by certain state and federal laws, you may need to report any accidental release if the spill quantity exceeds the "reportable quantity" of active ingredient specified in the law. Only a few of the pesticides routinely used in sod production are covered under these requirements. A complete list of pesticides and reportable quantities is available at the following website: <http://www.floridadisaster.org/cps/SERC/htc1.htm>.

Best Management Practices for Sod Farms



1.0 NUTRIENT MANAGEMENT¹

Modern fertility programs are complex in nature, resulting from the interaction of many factors. One important factor is fertilizer cost, which comprises an increasingly large portion of the total sod production expense. Because of this and the potential for nutrient-related adverse environmental effects on water resources, growers must understand the specific crop nutrient requirement (CNR) for their particular variety of turfgrass and are encouraged to fertilize wisely using scientific principles.

One of the first steps in developing a sound turfgrass fertilization management program involves a basic knowledge of soils. Many of Florida's soils naturally contain the required amount of phosphorus, assuming the pH levels are within the range to make this element available. As such, routine soil testing and analysis is considered to be a cornerstone of any nutrient management program. Nitrogen, which is not analyzed as part of a routine soil test, is a critically important macronutrient for vegetative growth. Plant tissue testing, which can detect plant nitrogen levels, can be used in conjunction with soil testing to diagnose the overall effectiveness of a fertilization program. It is especially useful to help a grower fine-tune their fertilizer application program.

Working Definition:

Nutrient management is the judicious application of fertilizers to meet the crop nutrient requirement without adding excess nutrients that may cause water quality problems.

1.1 Soil and Tissue Testing BMPs

Refer to Appendix 4 for important information on soil and tissue sampling.

- ✓ 1. Use a soil test from a lab using the Mehlich-1 or another method approved by UF-IFAS, Extension Soils Testing Laboratory to determine P fertilization rate..
- ✓ 2. Use tissue testing to diagnose the effectiveness of a fertilization program and to determine the need for supplemental fertilizer applications.
- Maintain records of all soil and tissue test results and sample locations.

Set realistic yield and maturity goals. Some growers believe that N fertilization is the key to quicker maturity and, therefore, set maturity goals at unrealistic and rarely achieved levels. Excessive N can force excessive sod top growth and reduce "liftability" of the sod.

¹ According to FDACS rule, applicable nutrient management practices must be implemented as soon as practicable after submittal of the *Notice of Intent*.

1.2 Standard Fertilization Practice BMPs

- ✓ 1. Know the CNR for N and P as specified in IFAS fertilization recommendations or other credible research and target this amount for total crop fertilization. In addition to specific fertilizer recommendations in this section, follow the general fertilizer application rates in the *Fertilization Guidelines for Sod Production* table on page 14 of this manual.
 - ✓ 2. Calibrate fertilizer application equipment. To the extent practicable, match the fertilizer bulk density to the equipment for maximum distribution uniformity.
 - ✓ 3. When applying soluble fertilizers, use smaller, more frequent applications to minimize potential for leaching.
 - ✓ 4. Avoid soluble fertilizer applications that exceed 50 lbs N/acre, and continue fertilizing throughout the season as needed. For newly planted fields or re-establishing ribbons, apply no more than 20 lbs soluble N/acre until the roots and grass begin to grow. Consider the use of precision application equipment to achieve this rate and to maximize production potential. Use extreme caution during this time as the sod's root system is not fully developed to intercept all available nutrients. Incrementally increase the fertilizer application rate in proportion to plant uptake potential.
 - ✓ 5. When possible, locate fertilizer loading activities away from ground water wells, ditches, canals, wetlands, sinkholes, and other sensitive areas.
 - ✓ 6. Only apply a supplemental application of N and/or K, when rainfall exceeds 3 inches in 3 days, or 4 inches in 7 days, when the results of a tissue analysis fall below the standard sufficiency ranges, or when documented plant stress results from saline water conditions.
- Maintain records of the amount and type of fertilizer used per application.

1.3 Special Fertilizer Application BMPs

- ✓ 1. Apply micronutrients only when a specific deficiency has been clearly diagnosed. Use foliar applications of micronutrients, including Fe, Mn, and B, especially on calcareous soils that tend to fix micronutrients in unavailable forms.

- ✓ 2. Obtain a soil survey and identify whether the soil series in the table below exist on the property. These soils are very prone to leaching P and are more common in areas of Central and South Florida.

Common Uncoated Soils			
Archbold	EauGallie	Myakka	Ridgeland
Allanton	Eglin	Narcoosee	Satellite
Ankona	Estero	Nettles	St. Lucie
Basinger	Hallandale	Oldsmar	Smyrna
Broward	Hobe	Palm Beach	Valkaria
Canaveral	Immokalee	Pepper	Wabasso
Dade	Jonathan	Pomello	Wauchula
Deland	Lawnwood	Pomona	Waveland
Dueette	Leon	Pompano	Zolfo

- ✓ 3. Use a mixture of controlled-release and soluble N fertilizer sources during sod establishment and around environmentally sensitive areas such as springsheds, sinkholes, and wetlands.
- ✓ 4. If using fertigation, apply after the root system has pegged-down or advanced into the inter-ribbon area.

1.4 Other Fertilizer Sources

- ✓ 1. If using reclaimed water, adjust nitrogen and phosphorous fertilization rates as appropriate.
- ✓ 2. Adjust fertilizer rate if using composted manures, treated domestic wastewater residuals, or other biosolids. Analyze these products before using them, to determine their nutrient concentrations.

Operation and Maintenance

- Store nitrogen-based fertilizers separately in a secure building away from solvents, fuels and pesticides. Many fertilizers are oxidants and can accelerate a fire.
- Excessive irrigation can result in fertilizer leaching. Remember that fertilizer and water management programs are linked. Maximum fertilizer efficiency is achieved only with close attention to water management.

Key References:

- (1) UF/IFAS Standardized Fertilization Recommendations for Agronomic Crops, <http://edis.ifas.ufl.edu/SS163>

- (2) Agronomic Crops and Forages,
http://jefferson.ifas.ufl.edu/ag_pages/crospage.htm
- (3) UF/IFAS Agronomy Department,
<http://agronomy.ifas.ufl.edu/AGPUBS.HTML>
- (4) Fertilization of Agronomic Crops,
<http://edis.ifas.ufl.edu/AA130>
- (5) Soil and Plant Nutrition,
<http://edis.ifas.ufl.edu/MG091>
- (6) Sod Production in Florida,
<http://edis.ifas.ufl.edu/LH066>
- (7) Best Management Practices for Alabama Sod Production. Alabama Agricultural Experiment Station, Auburn University, Auburn, Alabama 36849 July 2002
- (8) UF/IFAS Fertility Considerations for Sod Production,
<http://edis.ifas.ufl.edu/pdf/SS/SS16400.pdf>
- (9) UF/IFAS Soil Testing and Interpretation for Florida Turgrasses, <http://edis.ifas.ufl.edu/SS317>
- (10) UF/IFAS Selected Fertilizers used in Turfgrass Fertilization, <http://edis.ifas.ufl.edu/SS318>
- (11) NRCS Conservation Practice Standard No. 590



2.0 IRRIGATION SCHEDULING

Irrigation scheduling consists of a collection of technical procedures developed to forecast the timing and amount of irrigation events. Often, irrigation scheduling decision-making is not based solely on technical procedures, but also on local experience and other limitations introduced by irrigation system infrastructure. Technical approaches to irrigation scheduling are complex because they require an understanding of many factors, including: turfgrass species water needs, soils, climate, irrigation method(s), management objectives, and regulatory constraints. Most irrigation scheduling methods are ultimately based on two approaches: (1) monitoring soil and/or plant water status, and (2) determining a soil water budget that forecasts irrigation scheduling events based on estimated water depletion in the root zone.

Bear in mind that with the exception of muck land sod production areas, Florida's sandy and coarse-textured soils have low water holding capacities and generally cannot store more than a few days worth of a crop's water needs.

Working Definition:

Irrigation scheduling is a planning and decision-making tool that the farm manager uses to best determine the sod farm's irrigation water needs.

2.1 Monitoring Soil and Plant Water Status

- ✓ 1. Determine the available soil moisture content and maintain soil moisture within the recommended range for the crop and soil type. If soil moisture consistently remains near field capacity, over irrigation and nutrient leaching will likely occur.
- ✓ 2. If soil moisture sensors are used, test and calibrate them as recommended per the manufacturer, place them in representative areas of the field, and use the appropriate device for the crop and soil type.

2.2 Forecasting Crop Water Needs

- ✓ 1. Always manage irrigation and fertilization together. Poor irrigation management may undermine a well-designed fertilization program.
- ✓ 2. Determine the daily potential evapotranspiration (ET_p) levels and use these to help guide irrigation event decisions. For real-time ET_p information, go to the website <http://fawn.ifas.ufl.edu>.
- ✓ 3. Use water meters or equivalent measuring devices to determine how much water is actually applied.

- Keep records of irrigation amounts applied and total rainfall received. Use rain gauges to measure rainfall amounts.

2.3 Irrigation Scheduling

- ✓ 1. When irrigating, do not apply more water than the root zone can store. In general, apply no more than $\frac{1}{2}$ to $\frac{3}{4}$ inches of water to established sod fields. Adjust irrigation timing and amount to account for rainfall events and growth stage of the turfgrass.
- ✓ 2. Minimize application losses due to evaporation and wind drift by irrigating early in the morning or late in the afternoon. Losses are also minimized when cloud cover is abundant and wind speed is minimal.
- ✓ 3. When sub-surface irrigation is used, maintain the water table at the lowest practical level.
- ✓ 4. Avoid excessive irrigation that leads to runoff for high use irrigation activities, such as new sod establishment and/or irrigation of ribbons for re-establishment.

Key References:

- (1) ASABE Standard EP458, December 1994
- (2) Irrigation Scheduling for Water & Energy Conservation in the 80's, ASAE Publ.23-81, Am. Soc. Agric. Engr., St. Joseph, MI.
- (3) Water Use and Irrigation Management of Agronomic Crops, <http://edis.ifas.ufl.edu/AA131>
- (4) Basic Irrigation Scheduling in Florida, <http://edis.ifas.ufl.edu/AE111>
- (5) Efficiencies of Florida Agricultural Irrigation Systems, <http://edis.ifas.ufl.edu/AE110>
- (6) Tensiometers for Soil Moisture Measurement and Irrigation Scheduling, <http://edis.ifas.ufl.edu/AE146>
- (7) NRCS Conservation Practice Standard No.449, <http://www.nrcs.usda.gov>
- (8) ASCE, Evaporation and Irrigation Water Requirements, www.pubs.asce.org
- (9) Florida Green Industries Best Management Practices for Protection of Water Resources in Florida



3.0 IRRIGATION SYSTEM MAINTENANCE AND EVALUATION

Many Florida sod growers use center pivot, linear sprinkler, or seepage as their primary means of irrigation. The irrigation system should be well-maintained, and operated at the highest practicable level of irrigation efficiency and uniformity. Without proper maintenance, system efficiency and uniformity of water application tend to decrease over time because of aging, weathering, and component breakdown.

Maintenance programs vary according to the type of irrigation system. For example, maintenance of flood or seepage systems may be limited to operational checks of pump stations and structures, including cleaning and maintaining ditches. Maintenance programs for pressurized pipe systems generally involve filtration, chlorination/ acidification, flushing, and repair or replacement of clogged emitters. Efficiently managed irrigation systems help ensure uniform sod growth, conserve water, and reduce operation and maintenance costs.

Working Definition:

Irrigation system evaluation and maintenance are management activities designed to maintain irrigation system components in good working condition, so that the entire system can perform according to design specifications.


3.1 General Irrigation Maintenance

To maintain your irrigation system successfully, you must know its potential peak efficiency, and its operating efficiency at the time of system evaluation. You can contact a Mobile Irrigation Lab technician or FDACS representative to schedule an evaluation of the irrigation system. MIL services are available free of charge, and provide an irrigation system evaluation with recommendations regarding system upgrades, irrigation scheduling, and other maintenance items. Below are key BMPs applicable to all irrigation systems:

- ✓ 1. Determine the normal operating values for the irrigation system and its components.
- ✓ 2. Periodically check system uniformity, defined as the degree to which an irrigation system can apply equal amounts of water at different locations throughout a field.
- ✓ 3. Establish a written schedule for inspection and maintenance of all irrigation system components.
- ✓ 4. Test water quality at least once each year. Changes in water quality may affect maintenance and fertilization requirements.

3.2 System-Specific Irrigation Maintenance

As applicable to your irrigation system:

- ✓ 1. Inspect overhead sprinkler nozzles for wear and malfunction, and replace them as necessary. Also, check nozzles to ensure that the correct combination of spacing, operating pressure, and type exists for proper overlap. Ensure that all replacement nozzles and other parts have identical flow and pressure characteristics.
 - ✓ 2. Clean and maintain pump station and associated filtration equipment, so they operate at optimum levels.
 - ✓ 3. Remove debris and control weeds in irrigation ditches and canals, to maintain desired water flow and direction. Use erosion-control measures to prevent sedimentation problems. Maintain water-level control structures (such as culverts and risers) to conserve water.
 - ✓ 4. As needed, maintain land level design grade by re-grading.
-  Keep records on potential peak efficiency of the irrigation system, operating efficiency of the system, system-uniformity values, the evaluation and maintenance schedule, and maintenance performed.

Key References:

- (1) Efficiencies of Florida Agricultural Irrigation Systems, <http://edis.ifas.ufl.edu/AE110>
- (2) IFAS Extension Bulletin 217, <http://edis.ifas.ufl.edu>
- (3) IFAS Extension Bulletin 248, Backflow Requirements When Using Public Water Supplies, <http://edis.ifas.ufl.edu/>
- (4) Agricultural Engineering Fact Sheet AE-73, Potential Impacts of Improper Irrigation System Design, <http://edis.ifas.ufl.edu/>
- (5) Design of Agricultural Irrigation Systems in Florida, <http://edis.ifas.ufl.edu/AE064>
- (6) NRCS Conservation Practice Standard Nos. 442 and 351, <http://www.nrcs.usda.gov/>
- (7) ASABE Standard Practice No.: S395, S436.1, S447, and EP458, <http://asae.frymulti.com/default.asp>
- (8) IFAS Extension Bulletin 247, Efficiencies of Florida Agricultural Systems, <http://edis.ifas.ufl.edu/AE110>
- (9) The Irrigation Association, <http://www.irrigation.org>
- (10) Florida Irrigation Society (FIS), <http://www.fisstaterg.org/features.htm>
- (11) USDA NRCS Irrigation Web Page, <http://www.wcc.nrcs.usda.gov/nrcsirrig/>



4.0 SEDIMENT AND EROSION CONTROL MEASURES

The implementation of certain on-farm practices may inadvertently affect the quality of water discharged off-site. Removal of natural vegetation and/or topsoil in areas prone to soil erosion can change runoff characteristics and result in the loss of soil and increased sedimentation in water bodies. Other site sensitivity characteristics such as clay-type soils and/or sloped terrain can significantly increase the risk of erosion and offsite sediment transport. The end result is that sediments along with *adsorbed* nutrients and pesticides can increase the risk of contamination to surface waters or groundwater.

The first step in preventing erosion and sediment transport is to limit the amount of land that is cleared of vegetation and limit the loss of soil from sod fields. Examples of these types of BMPs which can help to accomplish this include conservation tillage, terraces, proper bed preparation, the use of silt screens, and critical area planting. The second step in preventing erosion and sediment transport involves the use of BMPs to limit the movement of sediments. Examples of these types of BMPs include sediment basins and diversions/terraces. Collectively, these management practices will reduce the mass load of sediment reaching a waterbody which will help improve water quality.

The use of more common erosion-control devices like silt screens, sediment traps, and sediment basins are described below. These BMPs should

be employed progressively, meaning that whenever sod growers are establishing new sod farm fields or cutting sod during the rainy season; the appropriate BMPs should be used based on prevailing land features and risks to water resources. Use vegetated buffers first and subsequently employ silt screens, sediment traps or sediment basins as the need arises. By following these practices, sod growers can do their part to prevent erosion and sedimentation impacts, which will not only protect the water resources but also will ensure long-term productivity of agricultural farmland.

Silt screens are temporary barriers used to provide physical removal of solids. Sediment traps are small excavated areas that temporarily slow irrigation tailwater to allow settling. They should be used when silt screens alone do not provide adequate water quality protection. Sediment basins temporarily trap runoff water and allow sediments to slowly settle out. These small “catchment basins” are typically constructed before or after a control structure and help keep surface waters clean by keeping sediments and other potential pollutants out of waterways. Settling of sediments and suspended material on the bottom of these basins will also tie up many nutrients and/or pesticides present in runoff, which also improves surface water quality. From a design standpoint, sediment basins differ from water management district permitted storm-

water treatment systems because of their smaller size and focus on sediment removal. In the case of most sod farms, they may be used as a stand-alone feature when sediment traps do not provide adequate water quality protection.

Anionic polyacrylamides, commonly referred to as “PAM”, are the most common chemical soil amendments for erosion control. They are water soluble high molecular weight polymers made up of many repeating subunits or monomers. “Polyacrylamide” and “PAM” are generic terms. The properties of various PAMs are very dependant on the size of the polymer. A familiar analogy in nature is the way simple glucose monomers are progressively polymerized into polysaccharides, pectins, starches, and cellulose. Anionic PAM is generally classified as an environmentally safe industrial flocculent and is widely used in municipal water treatment, paper manufacturing, food processing and other treatment applications.

The NRCS published an interim conservation practice standard for PAM use in January 1995. In that year about 50,000 acres were treated with PAM, realizing an estimated savings of up to one million tons of soil. The current Florida NRCS Conservation Practice Standard is Code 450. Use of anionic PAM is a BMP for both urban construction sites and agricultural lands to minimize irrigation or rainfall induced soil erosion.

4.1 Filter Strip Design and Construction

- ✓ 1. Install filter strips if needed. Design filter strips in accordance with USDA-NRCS specifications.

4.2 Silt Screen Design and Construction

- ✓ 1. Use silt screens when effective control is needed for 3 months or less. They are especially useful in sheet flow conditions but do not work in channelized flow conditions.
- ✓ 2. Install silt screens below disturbed areas and install them perpendicular to the direction of water flow. Trench in, backfill and compact silt screens in accordance with the Florida Stormwater, Erosion, and Sediment Control Inspector’s Manual in the reference section below.

4.3 Sediment Trap Design and Construction

- ✓ 1. Install sediment traps within the water conveyance system when recurring sedimentation problems occur.
- ✓ 2. Retrofit water control structures associated with sediment traps with flashboard risers.

4.4 Sediment Basin Design and Construction

- ✓ 1. Design the basin so that its storage capacity shall equal or exceed the volume of sediment that is expected to be trapped during the planned useful life of the basin.
- ✓ 2. Provide emergency drainage for safety and disease vector (e.g. mosquito) control.
- ✓ 3. Design the basin and outfall control structure to handle a 10-year storm event (discharge). The embankment should have a minimum top width of 4 feet, and at least 2 horizontal to 1 vertical side slopes.

4.5 Chemical Soil Amendments

- ✓ 1. Consider using PAM on non-peat soils, particularly in the non-vegetated areas such as roads, pivot wheel tracks or after harvest until ribbons have fully grown-in. This is especially important on heavier soils that are susceptible to erosion.
- ✓ 2. Contact your PAM supplier to conduct “jar tests” to match the specific properties of the PAM polymer to your site before application. The effectiveness of flocculent activity is very dependent on the properties of the specific soil type.
- ✓ 3. Adjust application rates based on soil properties, slope and type of erosion targeted and do not exceed 10 ppm. Because the use of PAM may result in an increase in infiltration on heavier soils, consider adjusting irrigation scheduling and/or tillage practices accordingly.
- ✓ 4. For seepage irrigation, consider using the product once during the advance phase which is the time until the “wetted front” has reached the end of the row. For sprinkler systems, multiple applications may be needed in order to maintain erosion control.

Operation and Maintenance

- Reuse sediment basin water for routine irrigation needs, so long as water volumes and quality warrant.
- Install safety fencing around sediment basins, especially if near highly urbanized areas.
- Remove any sediment deposits on silt screens when they reach one half the height of the barrier.

Key References:

- (1) USDA-NRCS Conservation Practice Standard Codes 350, 393, 450, 468, 638, 587, and 601
<http://www.nrcs.usda.gov/>
- (2) Farming for Clean Water in South Carolina: A Handbook of Conservation Practices <http://www.epa.gov/owow/nps/bestnpsdocs.html#agriculture>
- (3) The Florida Stormwater, Erosion, and Sedimentation Control Inspector's Manual, http://www.dep.state.fl.us/water/nonpoint/ero_man.htm
- (4) USDA Planning and Design Manual for the Control of Erosion, Sediment, and Storm water <http://www.abbe.msstate.edu/Tools/csd/p-dm/index.php>
- (5) FDEP and FDOT Design and Construction Manual



5.0 INTEGRATED PEST MANAGEMENT

Integrated pest management (IPM) is a philosophy of managing pests that aims to reduce farm expenses, conserve energy, and protect the environment. IPM does not mean that pesticides will be excluded. Instead, it means that pesticides are just one of many tools used to manage pests. Pesticides should be used judiciously and only when needed. The goals of an IPM program are improved control of pests, more efficient pesticide management, more economical sod protection, and reduction of potential hazards to humans and the environment through reduced pesticide exposure.

IPM accomplishes these goals through the use of resistant plant species, improved cultural practices, biological control agents (parasitoids, predators), and selective use of pesticides. Although detailed IPM programs have not been developed for all types of cropping systems, IPM principles can be applied in many cases using logic.

Working Definition:

IPM is a broad, interdisciplinary approach to pest management using a variety of methods to systematically control pests which adversely affect sod production and quality.

5.1 Planning Steps for an IPM Program

Predict economic losses and risks so the cost of various treatments can be compared to the potential losses. When possible, select disease- and pest-resistant varieties.


- ✓ 1. Identify key pests and beneficial organisms, their life cycles, and factors affecting their populations.
- ✓ 2. Select preventive cultural practices to minimize pests and enhance biological control strategies. These practices may include soil preparation, crop rotation, resistant species, modified irrigation methods, and augmenting beneficial insects, if applicable.

5.2 Specific IPM Practices

- ✓ 1. Routinely monitor or scout sod fields, borders, and adjacent vegetation for pests and disease activity. Conduct scouting at the appropriate time of the day and year to better observe pest *signs* and *symptoms*.
- ✓ 2. Select pesticides that will control target pests, and use them responsibly because they can also harm beneficial insects. Rotate use of insecticide and fungicide classes to delay resistance development.
- ✓ 3. Evaluate the feasibility of spraying certain pes-

ticides at night to protect day-active (diurnal) beneficial insects.

- ✓ 4. Choose a chemical compound that has lower toxicity to aquatic organisms when applying a pesticide close to a stream, canal or pond and observe appropriate buffer requirements.
- ✓ 5. Coordinate pesticide applications with appropriate soil moisture conditions, weather forecasts, and irrigation scheduling requirements for effective application.

 Maintain records to measure the effectiveness of IPM strategies.

5.3 Mix - Load Activities

- ✓ 1. Store crop protection products in a roofed concrete or metal structure with a lockable door, and locate this structure at least 50 feet from other structures and 100 feet from surface waters.
- ✓ 2. When practical, construct a permanent mix/load facility with an impermeable surface, and locate it away from wells and/or surface waters. Where permanent facilities are not practical, use portable mix/load stations. When field mixing is necessary, loading activities should be conducted at random locations in the field with the aid of nurse tanks. Use a check valve or air gap separation to prevent backflow into the nurse tank when filling a sprayer.
- ✓ 3. Develop and implement procedures to appropriately rinse, recycle, or dispose of empty crop protection product containers.

Key References:

- (1) Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance by the Florida Department of Agriculture and Consumer Services and the Florida Department of Environmental Protection, <http://www.floridaagwaterpolicy.com/BestManagementPractices.html>
- (2) Integrated Pest Management Program at the University of Florida, <http://ipm.ifas.ufl.edu/>
- (3) USDA Regional Pest Management Centers Information System, <http://www.ipmcenters.org>
- (4) Southern Region Pest Management Center, <http://www.pmcenters.org/southern/>
- (5) Integrated Pest Management in the Southern Region, <http://ipm-www.ento.vt.edu/nipmn/>
- (6) Biocontrol Web Site, <http://cmave.usda.ufl.edu/biocontrol/>
- (7) University of Florida, Entomology and Nematology Department, <http://entnemdept.ifas.ufl.edu/>
- (8) IFAS Circular PI-1, Use Management Practices to Protect Groundwater from Agricultural Pesticides, <http://edis.ifas.ufl.edu/PI001>
- (9) IFAS Circular 1149, Integrated Pest Management Strategies, <http://edis.ifas.ufl.edu/LH080>
- (10) IFAS Pest Control Guide for Turfgrass Managers http://jefferson.ifas.ufl.edu/ag_pages/2006TurfPestControlGuide.pdf
- (11) NRCS Conservation Practice Standard Nos. 595, 702, 703



6.0 WELLHEAD PROTECTION

With the majority of Florida's existing water supply coming from groundwater sources (aquifers), coupled with the increases in demand that have been projected, it is extremely important that growers make every effort to protect this valuable resource. Wellhead protection, which involves the use of regulations and common-sense measures related to well placement and practices near wells, is one of the most important ways to protect the quality of groundwater sources. Over-pumping of high capacity agricultural irrigation wells may result in unforeseen problems, such as salt water intrusion, cross contamination of different aquifers, and/or inadvertent movement of potential contaminants within the well's zone of influence.

Working Definition:

Well head protection is the establishment of protection zones and safe land use practices around water supply wells in order to protect aquifers from accidental contamination. These practices are mandated by rule for public and private drinking water wells, but should be considered BMPs for all wells.

6.1 Well Planning


- ✓ 1. Review your local comprehensive plan to see if land uses within wellhead protection areas conform to local codes.

- ✓ 2. Contact your regional water management district to see if the well requires a consumptive use or water use permit. Wells that serve public water systems must also meet FDEP rule requirements in Chapter 62-521, F.A.C.
- ✓ 3. Properly plug or valve abandoned or flowing wells before constructing any new wells.
- ✓ 4. Construct wells as far as possible upgradient from likely pollutants such as fuel tanks, septic tanks or chemical mixing areas. Ensure that fuel tanks are properly designed, contained and registered.

6.2 Well Drilling and Operation

- ✓ 1. Use a licensed Florida water well contractor and drill new wells according to local government code and water management district well construction permit requirements.
- ✓ 2. Shallow wells should be properly screened, and deep wells should be cased at least 10 feet into the aquifer bed.
- ✓ 3. Surround new wells with a concrete slab that is at least 4 inches thick and 2 feet wide in all directions. Extend casing above ground surface a minimum of 12 inches.
- ✓ 4. Use backflow prevention devices when fer-

tigating or chemigating in accordance with state regulations.

-  Maintain records of well construction. Proper records are important in case problems arise with the well.

Operation and Maintenance

- When feasible, verify the integrity of older wells. Many existing wells have no construction records and logging these wells can verify proper casing depths and integrity. Where possible, retrofit existing wells with a small concrete pad, as specified in 6.2.3, to protect the area around the casing.
- Inspect wellheads and pads regularly for leaks or cracks and repair them promptly.

Key References:

- (1) NRCS Conservation Practice Standard No. 642, <http://www.nrcs.usda.gov/technical/efotg>
- (2) Farming for Clean Water in South Carolina: A Handbook of Conservation Practices
- (3) SJRWMD Aquifer Protection Program, <http://sjr.state.fl.us/>
- (4) FDEP Rule 62-532, F.A.C.



7.0 WETLANDS AND SPRINGS PROTECTION

Wetlands and springs are important components of Florida's water resources. They often serve as spawning areas and nurseries for many species of fish and wildlife, perform important flood-storage roles, cycle nutrients in runoff water, contribute moisture to the hydrologic cycle, add plant and animal diversity, and provide valuable recreational opportunities for the public. Wetlands are complex transitional ecosystems between aquatic and terrestrial environments.

Springs, spring runs, and associated sinks are unique freshwater systems that emerge from the underlying limestone which is at or near the land surface. Prior to substantial development in Florida, wetlands and spring systems once covered about half of the state's surface. Today, that area has been greatly reduced, primarily because early water management efforts in Florida focused on draining wetlands to facilitate urban and agricultural lands development.

Under Florida Law, "wetlands" are defined as areas that are inundated or saturated by surface water or groundwater at a frequency and a duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils. Florida wetlands generally include swamps, marshes, bayheads, bogs, cypress domes and strands, sloughs, wet prairies, riverine swamps and marshes, hydric seepage slopes, tidal marshes, mangrove swamps and other similar areas.

Florida wetlands generally do not include longleaf or slash pine flatwoods with an understory dominated by saw palmetto. Chapter 62-340, F.A.C., entitled "Delineation of the Landward Extent of Wetlands and Surface Waters" contains the methodology that must be used by all state and local governments in Florida to determine the boundary between wetlands and uplands and other surface waters. The federal government (U.S. Army Corps of Engineers) uses the "1987 Manual" to determine the boundary between uplands and waters of the United States. In most cases, the boundaries determined by both methodologies are the same or very close.

Working Definition:

Wetlands are waters of the state and are defined in section 373.019(25), F.S. They are typically low landform areas with seasonal or permanent standing water that provide wildlife habitat and natural filtration. Springs are mostly clear surface water bodies that are naturally low in nutrients and originate from groundwater that emerges to the land surface.

7.1 Wetland Protection and Impact Avoidance

- ✓ 1. Use a county soil survey to help identify wetland soil types and/or other depressional areas – both of which may be unsuitable for crop cultivation.

- ✓ 2. Use preservation, practical design alternatives, or modifications to eliminate or reduce adverse impacts to wetlands and other surface waters. Use the buffers prescribed below, unless the sod farm has an existing water management district permit. In this case, follow the buffer requirements set forth in permit.
- ✓ 3. Maintain a minimum 25-foot undisturbed upland buffer exterior to the landward extent of all perennial watercourses and associated adjacent wetlands.
- ✓ 4. Maintain a minimum 15-foot undisturbed upland buffer exterior to the landward extent of all on-site isolated wetlands.

7.2 Water Quality Treatment and Field Discharges

- ✓ 1. Minimize adverse water quality impacts to receiving wetlands by using a treatment train concept. Pretreatment practices such as filter strips, buffers, swales, or holding water onsite can substantially reduce pollutants, especially suspended solids, and allow the wetland to more naturally assimilate nutrients.
- ✓ 2. On steep slopes with a history of sedimentation impacts, consult with NRCS or FDACS staff to design and install upland sediment sumps landward of upland buffers to prevent scouring and minimize sediment transport.
- ✓ 3. Use spreader swales and other means to encourage sheet flow through the upland buffer prior to discharging into wetlands, and maintain pre-development point(s) of discharge.

7.3 Special Criteria for First and Second Magnitude Spring Basins

- ✓ 1. Create and maintain a 100-foot upland buffer from springs, spring runs and wet sinks.
- ✓ 2. Develop and implement a written Irrigation and Nutrient Management Plan that incorporates measures to reduce the release of nutrients.
- ✓ 3. Use controlled-release fertilizer and/or split applications on production areas that contribute surface water directly to springs, spring runs, and wet sinks.

Operation and Maintenance

- Limit the use of pesticides and fertilizers in and around wetlands and springs and be careful to avoid spray drift impacts.
- Do not impact any wetlands without first contacting USDA-NRCS staff, so that you will not jeopardize any federal program benefits.

Key References:

- (1) NRCS Conservation Practice Standard Nos. 326 and 659, <http://www.nrcs.usda.gov/technical/efotg>
- (2) Farming for Clean Water in South Carolina: A Handbook of Conservation Practices
- (3) Water Management Districts' Environmental Resource Permitting Rule and Basis of Review
- (4) Department of Community Affairs, Protecting Florida's Springs, Land Use Planning Strategies and Best Management Practices. www.dca.state.fl.us/fdcp/DCP/publications
- (4) FGS Bulletin 66, Springs of Florida www.dep.state.fl.us/geology/geologictopics/springs/bulletin66.htm



8.0 DITCH CONSTRUCTION AND MAINTENANCE

Agricultural ditches and/or grassed waterways are essential components of the sod-field site plan and layout. As such, they can vary from field ditches to laterals and mains, which are sometimes connected to larger canal systems. Depending upon their configuration, ditches have an engineered limit or *conveyance capacity* that governs how much water the ditch can store or convey. It is important to know the type of turfgrass you are growing and its specific water requirements so that you can capitalize on existing soil moisture conditions before designing ditches.

An effective sod-field ditch network functions primarily to convey and distribute water without causing excessive erosion, water losses, and/or degradation of water quality to the downstream receiving system. Properly designed and constructed agricultural ditches are very important; however, equally important is the implementation of an appropriate maintenance program to ensure that the ditches function as designed.

Working Definition:

Agricultural ditches are constructed trenches dug for the purpose of removing excess water from the land and/or providing irrigation water for use by the crop(s).

8.1 Planning and Design

- ✓ 1. Use mapping tools such as topographic maps, soil survey maps, and basic knowledge of the landscape to identify land contours, seasonal high watertable limitations and/or natural drainage outlets in order to plan the proposed ditch system.
- ✓ 2. Use appropriate setback distances when drainage ditches are located close to jurisdictional wetlands to avoid lowering the water table.

8.2 Ditch Construction

- ✓ 1. Stake the proposed ditch run and remove obstacles beforehand as needed. Construct ditches with spacing, depth, and side-slope consistent with on-site soil types. Refer to the USDA-NRCS Florida Drainage Guide for information on recommended construction based on specific soil types.
- ✓ 2. Follow appropriate grades and plans, as specified during ditch excavation. *Spoil* material should be deposited in an upland location or reused on the farm field.
- ✓ 3. During ditch construction, use temporary sediment and erosion control BMPs to minimize erosion and prevent water quality degradation.
- ✓ 4. Stabilize bare soils and newly constructed ditch

banks through the permanent establishment of sod, native grasses, or other appropriate vegetative cover.

- ✓ 5. Install lateral ditches as needed to maintain adequate drainage, crown sod field beds, and create drainage outlets to discharge excess water. If installing grassed waterways as an alternative to ditches, design and construct them in accordance with USDA-NRCS specifications.

8.3 Systematic, Routine, and Custodial Maintenance

- ✓ 1. Routinely maintain ditches. Sediments in ditches reduce the cross-sectional area, increase the water velocity, and can lead to sediment deposition downstream. Spread sediment material back on field upland areas or roads.
- ✓ 2. Maintain a permanent vegetative cover where shallow water furrows are used. Selectively control broadleaf vegetation on ditch banks to maintain a grass cover compatible with turfgrass selection. Do not fertilize or use agrichemicals which are not labeled for aquatic use in these areas.
- ✓ 3. Protect ditch banks from erosion in areas subject to high water velocities, using *rip-rap*, concrete, headwalls, or other buffering materials.
- ✓ 4. Keep permanent records of the design cross-sectional area using basic survey techniques to define the ditch profile. This is especially important for large ditches that have a tendency to “fill in” over time, and may assist you in dealing with regulatory agencies having jurisdiction over surface waters.

8.4 Floating Aquatic Weed Control

- ✓ 1. Routinely remove any accumulated aquatic weeds at the riserboard control structure(s) to maintain proper drainage and prevent secondary environmental impacts.
- ✓ 2. Use a combination of physical control (e.g. floating barriers, screens, etc.), biological control (e.g. herbivorous fish), and chemical control (e.g. selective herbicides labeled for aquatic applications) to suppress and reduce weed problems.

Operation and Maintenance

- Maintain ditch bank side slopes per the applicable soil type. When side slopes exceed design standards or vegetation is absent, growers should install other site-specific BMPs to minimize erosion.

Key References:

- (1) NRCS Conservation Practice Standard Nos. 388, 412, 607 and 608, <http://www.nrcs.usda.gov/>
- (2) American Society of Agricultural and Biological Engineers (ASABE) Standard EP 302.4, Design and Construction of Surface Drainage Systems on Agricultural Lands in Humid Areas
- (3) American Society of Agronomy: Drainage for Agriculture, <http://www.agronomy.org>
- (4) The Florida Stormwater, Erosion, and Sedimentation Control Inspectors' Manual, http://www.dep.state.fl.us/water/nonpoint/ero_man.htm
- (5) Water Management Districts' Environmental Resource Permitting Rule and Basis of Review



9.0 CONSERVATION BUFFERS

Conservation buffers include field borders, riparian buffers, and other non-production areas to conserve soil and water resources. Field borders are strips of permanent vegetation, either natural or planted, at the edge(s) of sod production fields. Field borders function primarily to reduce erosion from wind and water, protect soil and water quality, and provide wildlife habitat. Field borders can also be used as a management tool to help reduce harmful insect populations and can provide turning areas for farm equipment. A *riparian* buffer consists of natural shrub or forested vegetation adjacent to a watercourse to help reduce excessive amounts of sediment, organic material, nutrients, and pesticides in surface runoff from production areas. Riparian buffers also help to reduce excess nutrients and other chemicals in groundwater *lateral flow* that contributes to a receiving stream system's base flow. Riparian buffers are most effective on highly sloped lands when positioned next to perennial or intermittent streams, and areas with high groundwater recharge potential.

Working Definition:

Conservation buffers are permanently vegetated areas that function to conserve water and soil on site. A field border is a strip of permanent vegetation established at the edge of or around the perimeter of a farm field. A riparian buffer is generally an area of trees and/or shrubs located adjacent to natural watercourses.

9.1 Field Border Design and Construction

- ✓ 1. Plan and design your fields so that the field borders are wide enough to allow them to function as turn rows for equipment.
- ✓ 2. Locate borders around the entire perimeter of the field for optimal benefit or, at a minimum, in areas where runoff enters or leaves the field.
- ✓ 3. Where needed, construct berms or other diversions to break up or redirect concentrated water flow within the borders.
- ✓ 4. Plant borders using native species that are adapted to your climate and soil. Include herbaceous plants that attract beneficial insects and provide wildlife food and cover. Consider over-seeding the border with legumes for plant diversity and wildlife benefits.

9.2 Riparian Buffer Design and Construction

- ✓ 1. Install a riparian buffer on sod production areas that exceed 1% slope and discharge to perennial or intermittent watercourses.
- ✓ 2. Include a zone (identified as zone 1) that begins at the normal water line, or at the top of the bank, and extends a minimum distance of 15 feet landward.
- ✓ 3. Include a zone (identified as zone 2) that

begins at the edge or landward extent of zone 1 and extends a minimum distance of 20 feet, and expand this distance up to 30% of the active floodplain width, as applicable. An additional zone 3 may be needed to address concentrated flow erosion.

- ✓ 4. Locate and size watercourse crossings to minimize impacts to buffer vegetation and function.
- ✓ 5. Construct buffers in accordance with USDA-NRCS Conservation Practice Nos. 390 or 391, as appropriate. Contact USDA-NRCS or FDACS to determine whether the installation of riparian buffers may be eligible for cost-share.
- ✓ 6. Use two or more native shrub and tree species based on their compatibility in growth, water and shade tolerance. Select species that resprout when establishing buffers nearest to watercourses.

Operation and Maintenance

- Remove sediment when 6 inches or more have accumulated at the field border.
- Repair rills and small channels that may develop across the border, and reseed as necessary.
- Control grazing if livestock have access to field borders.
- Inspect the buffer periodically, and restore as needed in order to maintain the intended purpose(s).

- Any use of fertilizers, pesticides and other chemicals to assure buffer function shall not compromise the intended purpose.
- Removal of tree and shrub products is permitted in all zones in accordance with recognized Florida BMPs. Replace dead trees or shrubs and carefully control undesirable vegetation to reduce competition.

Key References:

- (1) NRCS Conservation Practice Standard Nos. 386, 390, 391, 393 and 412, <http://www.nrcs.usda.gov/technical/efotg>
- (2) NRCS FL Technical Note Forestry FL-17, General Specifications for Establishing Riparian Forest Buffers, USDA, 1979, <http://www.usda.nrcs.gov/>
- (3) Management For Wildlife, A Supplement to Wildlife Standard and Specifications for Florida. Gainesville, FL.
- (4) Florida Forest Service Silviculture BMP Manual, 2000.
- (5) Best Management Practices for Alabama Sod Production. Alabama Agricultural Experiment Station, Auburn University, Auburn, Alabama 36849 July 2002
- (6) Farming for Clean Water in South Carolina – A Handbook of Conservation Practices.
- (7) Predicting Soil Erosion by Water, A Guide to Conservation Planning with the Universal Soil Loss Equation (RUSLE). 1997. USDA Agricultural Research Service, Agricultural Handbook No. 703.



10.0 STORMWATER MANAGEMENT

Florida receives an average of 53 inches of rain per year. However, rainfall amount varies across the state by region, season, and year. Average rainfall tends to decrease as you move toward the central and southeastern parts of the state, and increase as you move toward the northwestern part of the state. In general, rainfall tends to occur more frequently during the summer months in Florida, especially in the central and southern areas of the state.

Alteration of the land, which may include construction of impervious surfaces such as roads, driveways, parking lots, urban and agricultural structures, etc., increases stormwater runoff during rainfall events. Improper stormwater management leads to on-site and offsite flooding, increased pollutant loading to surface and ground waters, erosion and sedimentation, and the loss of valuable fresh water resources. The need to address these stormwater impacts has led to the implementation of a comprehensive stormwater management program that is implemented cooperatively by FDEP and the water management districts (WMDs) to minimize flooding and stormwater pollution. Additionally, local governments and property owners have specific stormwater management responsibilities.

All new development activities, and some agricultural activities, especially those that alter on-site hydrology, are required to obtain an Environmental Resource Permit (ERP). The construction of a

stormwater management system (e.g., retention or detention pond) may require an ERP or other WMD surface water management permit. Therefore, please check with your water management district before beginning construction of any stormwater management system.

While sod farming generally does not lead to stormwater problems, there may be individual farm circumstances that create the need for specific stormwater management practices. Some farms may already have an ERP or other WMD surface water management permit that incorporates onsite stormwater management requirements. However, if stormwater problems exist and are not addressed by a WMD permit, it is important that a sod grower develop and implement a stormwater management plan suited to the farm's unique circumstances.

Working Definition:

Stormwater management is the on-site management of rainfall and runoff through the use of nonstructural and structural BMPs to provide flood protection and water quality protection in the most cost-effective manner.

10.1 Stormwater Management Planning and Implementation

✓ 1. If stormwater problems exist and are not

addressed by an ERP or other WMD surface water management permit, develop and implement a written stormwater management plan that specifically addresses various levels of rainfall, with the goal of reducing the volume of off-site discharge while maintaining an adequately drained root zone. Include guidelines for regular inspection of BMPs, and steps to implement operation and maintenance provisions.

- ✓ 2. Operate and maintain the stormwater management system to meet design performance criteria.
- ✓ 3. Evaluate the effectiveness of the plan, and make adjustments as needed.

In developing a stormwater management plan:

- Contact your local NRCS District Conservationist to obtain information about the soil types for the proposed or existing sod farm location. The District Conservationist can identify soil types that are historically prone to flooding or standing water. Evaluate the storage capacity, size, and elevations of existing ditches, ponds, creeks, rivers, and wetlands, and the size, layout, and elevations of the fields. You should also contact your county or water management district to obtain maps (FEMA, FIRM) or other information related to flooding issues at the proposed or existing location. You can access this information via the web at <http://www.fema.gov/hazard/map/firm.shtm>.
- Determine the maximum storm size for which you want to provide flood protection. The flood control design storm addressed by WMD ERP regulations varies from a 25-year, 24-hour storm to a 100-year, 3-day storm. For example, a 25-year, 24-hour storm produces from 8 to 10 inches of rainfall in a 24-hour period. Generally, the larger the design storm event used, the more extensive the stormwater management system needs to be. Factors that will affect this decision include land availability, the existence of internal natural features such as creeks, rivers, ponds, or wetlands, the potential to flood downstream property owners, and costs.
- Consult with a public or private agricultural engineer to discuss your stormwater management needs and considerations, especially if you are farming on marginal lands. Find an engineer qualified to provide an appropriate stormwater runoff analysis for your site.
- Include both nonstructural pollution prevention BMPs and structural BMPs, as needed.

Key References:

- (1) NRCS Conservation Practice Standard Nos. 554 and 570, <http://www.nrcs.usda.gov/technical/Standards/nhcp.html>
- (2) Water Management Districts ERP Manuals, Basis of Review, Appendices
 - NWFWMMD
<http://www.nwfwmd.state.fl.us/permits/ruleform.htm>
 - SFWMD
https://my.sfwmd.gov/portal/page?_pageid=734,1456414,734_1456346&_dad=portal&_schema=PORTAL&navpage=regulatoryguidance
 - SWFWMD
http://www.swfwmd.state.fl.us/rules/files/40d_basis_of_review.pdf
 - St. Johns WMD
http://www.sjrwmd.com/govboard/pdfs/ERP_gen_conditions.pdf
 - Suwannee River WMD
http://www.srwmd.state.fl.us/resources/40b-4-atvofficialupdate10-25-05_2_.pdf
- (3) ASABE Standard No. EP302.4 <http://asae.frymulti.com/abstract.asp?aid=14738&t=2>
- (4) Florida Engineering Society Directory and Guide, <http://www.fleng.org/pubs.cfm#FICEdandg>



11.0 ACCESS ROADS

Agricultural access roads provide a fixed route for vehicles and farm equipment, and offer both ingress and egress for associated sod farms. Access roads range from seldom used “trails” to more substantial all-weather roads that offer greater year-round accessibility. Permanent sod farms require well-constructed roads to support the necessary vehicle weight associated with the transport of cut sod to market.

Properly constructed access roads help prevent water quality impacts by eliminating the formation of gullies; however, improperly constructed access roads are a potential source of long-term erosion and sedimentation problems. Moreover, access roads that are constructed entirely in uplands, constructed at or near grade, and that meet a minimum set of specifications will generally result in little to no impacts on water resources. Lastly, construction of access roads that result in the alteration of flow patterns may require a permit from the water management district, so check with them before proceeding.

Working Definition:

Agricultural access roads are generally upland constructed travel lanes designed to provide all-weather field entry without causing significant erosion and water quality impacts.

11.1 Road Planning

- ✓ 1. Plan the location of the road and desired drainage features before construction, using soil survey maps, *topographic maps*, and/or available aerial photography in order to minimize watercourse crossings.
- ✓ 2. Locate elevated access roads a minimum of 25 feet from regulated wetlands and other watercourses, except at crossings.
- ✓ 3. Provide a turnaround area at the end of dead-end access roads.

11.2 Road Construction and Drainage

- ✓ 1. Construct the road during dry conditions, use pervious construction materials, and try to complete construction several months before the rainy season begins and before the road is to be used.
- ✓ 2. Balance cuts and fills to maximize the use of local materials, and to provide for good roadbed stability.
- ✓ 3. Minimize road widths consistent with the type and size of vehicles.
- ✓ 4. Keep road shoulders at a gentle slope for fill road construction in order to minimize erosion and to ensure adequate vegetative cover of

road shoulders. Slopes should not be steeper than 2:1 (horizontal to vertical) side slopes on cuts or fills.

- ✓ 5. Maintain pre-development hydrologic conditions or follow permit requirements as applicable. Use adequately sized and designed culverts, cross ditches, turnouts, and gravel crossings consistent with sound engineering principles.
- ✓ 6. Do not exceed 10 percent grades and use surface crowning to help direct road runoff into associated roadside swales. When access roads are adjacent to canals, wetlands, or other waterbodies, the roads should be sloped towards field production areas.
- ✓ 7. Stabilize soils with vegetation or armor around the culverts to prevent erosion when crossing watercourses.

Operation and Maintenance

- Check drainage structures periodically to maintain their function.
- Regularly repair soft spots, ruts and potholes in roads.
- Maintain vegetative cover on road banks and re-seed and mow as needed.

Key References:

- (1) NRCS Conservation Practice Standard No. 560, <http://www.nrcs.usda.gov/>
- (2) FDEP Stormwater and Erosion Control BMPs for Developing Areas, Chapter 6
- (3) Florida Stormwater Erosion & Sediment Control Inspection Manual, http://www.dep.state.fl.us/water/nonpoint/ero_man.htm
- (4) Florida Forest Service Silviculture BMP Manual, 2000.



12.0 MOWING MANAGEMENT

Mowing is an essential activity in sod production to control sod growth and inhibit weeds. Mowing encourages lateral growth and careful attention to it will result in a high-quality sod. It is important to set up a mowing schedule and to properly maintain equipment to minimize turf stress. Clippings from mowing must be managed to prevent negative impacts to water quality.

Working Definition:

Mowing is the cutting of sod fields to a specific height on a regular schedule in order to inhibit weed growth and promote lateral growth of the turf.

12.1 Mowing

When proper mowing frequency is followed, clipping removal in sod production operations is typically not necessary. Increased mowing frequency promotes more rapid establishment and minimizes duration of bare soil exposure.

- ✓ 1. Select mowing equipment appropriate for the sod variety and field conditions.
- ✓ 2. Establish a mowing frequency to maintain optimal turf growth. Increased mowing frequency promotes more rapid establishment and minimizes duration of bare soil exposure.
- ✓ 3. Recycle, compost, or dispose of clippings in an environmentally acceptable fashion. Use

care to minimize the build-up of clippings in waterways and irrigation ditches. Sweepers or vacuums may be used to prevent grass clippings from collecting within the sod.

Operation and Maintenance

- Mowers should be cleaned regularly and between fields if possible to reduce the spread of diseases, grass species, or pests.
- Keep mower blades sharp and well maintained to avoid damaging the sod.
- Sod being grown for seed production (for example, centipede) will be mowed less frequently. When the seed harvest is complete, collect and compost clippings.

Key References:

- (1) Best Management Practices for Alabama Sod Production. Alabama Agricultural Experiment Station, Auburn University, Auburn, Alabama 36849 July 2002
- (2) UF/IFAS Sod Production in Florida, <http://edis.ifas.ufl.edu/LH066>
- (3) Florida Green Industries, Best Management Practices for Protection of Water Resources in Florida, June 2002
- (4) Best Management Practices for Enhancement of Environmental Quality on Florida Golf Courses, 2007



13.0 SEASONAL FARMING OPERATIONS

Sod farmers typically operate year round. However, some sod farmers may also conduct associated ranching operations and practice a type of rotational farming where pastures are periodically renovated and planted in grass cover. Much of the agricultural land in South, South-Central and Southwest Florida is managed for cattle grazing. As such, ranching and compatible agricultural production systems such as sod farming are generally recognized as low-intensity agricultural uses. When properly managed, this type of operation provides year-round vegetative cover, thus benefitting soil and water properties overall. Some sod producers will harvest bahia grass from their pastures every fifth year or so, and this practice coincides with the establishment of improved pasture grasses.

Cow/calf operations with periodic rotations of sod should follow the criteria set forth in this chapter; and, during cattle-grazing periods, owners should follow the BMP practices in the “*Water Quality Best Management Practices for Cow/Calf Operations in Florida*”. Sod farmers not engaged in associated cow/calf operations should follow the BMPs prescribed elsewhere in this manual.

Working Definition:

Seasonal or temporary farms include planned and sequenced agricultural activities on relatively defined project areas for a limited time period. These farms,


following completion of harvest, generally practice hydrologic restoration (return to pre-development conditions) and cover cropping.

13.1 Crop Planning and Design

- ✓ 1. Grow sod in a planned, regular scheme and rotation. Select appropriate species adapted to the local climate and soil conditions. Certain grasses such as bahiagrass are particularly suited when used in conjunction with cattle rotations.
- ✓ 2. Select cover or rotational crops that can add organic matter to the soil.
- ✓ 3. Know the carbon to nitrogen (C:N) ratio of any residue being incorporated into the soil. In general, materials that have a C:N ratio higher than 20:1 may temporarily immobilize inorganic nitrogen and produce nitrogen deficiencies in subsequent crops.

13.2 Fallow Requirements and Field Abandonment

- ✓ 1. Incorporate an average three-year sod rotation interval and follow minimum *fallow* requirements. If soil tests show a decreasing organic matter trend, then follow USDA-NRCS residue index recommendations.

- ✓ 2. Use appropriate wetland setbacks as referenced in the *Wetlands and Springs Protection BMP* in this manual.
- ✓ 3. Restore all agricultural surface water management system features (ditches) to pre-development hydrologic conditions.
-  Keep permanent records of crop history, rotation intervals, etc.

13.3 Clippings Management

- ✓ 1. Adjust mowing height to promote an increase in turf density, root health, and less clippings. In general, a grass that spreads horizontally can usually be mowed shorter than an upright, bunching grass. Mow bahia grass to a height of 3 to 4 inches.
- ✓ 2. If clumping occurs, use equipment to lightly rake and distribute clippings over the entire sod field.
- ✓ 3. Store removed clippings on upland areas that have less than a 3 percent slope.
- ✓ 4. Compost the clippings and/or use the clippings for livestock feed.

Operation and Maintenance

- Use nutrient management practices. Conduct soil tests, follow the recommendations, and include the nitrogen contribution of legumes if planted.
- Incorporate crop residues into the soil to increase infiltration, reduce runoff, and improve soil moisture holding ability.
- Use irrigation management practices, as applicable.

Key References:

- (1) NRCS Conservation Practice Standard No. 328
<http://www.nrcs.usda.gov/technical/efotg>
- (2) Farming for Clean Water in South Carolina – A Handbook of Conservation Practices
- (3) Best Management Practices for Alabama Sod Production
- (4) Florida Green Industries, Best Management Practices for Protection of Water Resources in Florida
- (5) Southwest Florida Water Management District, Agricultural Ground and Surface Water Management Program
- (6) UF-IFAS Standardized Fertilization Recommendations for Agronomic Crops, SL-129

APPENDICES

APPENDIX 1. ADDITIONAL BMP REFERENCES

General BMP References

- (1) *Best Management Practices for Alabama Sod Production*, Auburn University, July 2002.

This manual provides an overview of agronomic issues of sod production, various environmental protection practices, pest and pesticide issues, as well as information on species selection and warm season species. Currently, this manual does not reside on any website.

- (2) *Best Management Practices for Agrichemical and Farm Equipment Maintenance*, Florida Department of Agriculture and Consumer Services, Florida Department of Environmental Protection, February 2000

This manual lists responsible handling and use of pest control products, and pollution prevention actions that can be implemented at farm maintenance areas that protect the environment.

<http://www.floridaagwaterpolicy.com/BestManagementPractices.html>

- (3) *Florida Green Industries Best Management Practices for Protection of Water Resources in Florida*, Florida Department of Environmental Protection, Florida Turfgrass Association, June 2002

This manual provides information and guidance on turfgrass and landscape management practices to protect Florida's water resources. It is designed as an education guide for professional service providers.

<http://www.dep.state.fl.us/water/nonpoint/pubs.htm#URBAN%20POLLUTION%20PREVENTION>

- (4) *Protecting Florida's Springs: Land Use Planning Strategies and Best Management Practices*, Florida Department of Community Affairs and Florida Department of Environmental Protection, November 2002.

This guide provides an introduction on the hydrologic importance of springs, comprehensive planning strategies, other information to manage development impacts, and specific criteria for other industries. <http://www.dca.state.fl.us/fdcp/DCP/publications>

- (5) *The Florida Irrigator's Pocket Guide*, National Center for Appropriate Technology, USDA-Natural Resources Conservation Service, 2005

This guide lists both water management and equipment management practices and includes a schedule of common maintenance tasks. The guide also focuses on conserving and protecting water, soil, energy and natural resources. Currently, this guide does not reside on any website.

- (6) *Water Quality/Quantity Best Management Practices for Florida Vegetable and Agronomic Crops*, Florida Department of Agriculture and Consumer Services, University of Florida – IFAS, Florida Department of Environmental Protection, 2005 Edition.

This manual provides a comprehensive list of 49 Best Management Practices which are used state-wide for vegetables and agronomic crops. Nutrient and irrigation management practices are combined in one chapter, as these measures are inextricably linked for most row crop activities.

<http://www.floridaagwaterpolicy.com/BestManagementPractices.html>

- (7) *Best Management Practices for Enhancement of Environmental Quality on Florida Golf Courses*, 2007.

This 136 page book discusses possibilities for environmental stewardship and pollution prevention at golf courses. It supersedes and expands upon the 1995 BMP document. This new document was written by FDEP in coordination with the Florida Golf Course Superintendents Association, Audubon International, the University of Florida, and many others. It is designed for used by superintendents, managers, and employees; developers and designers; planners and regulators; and concerned citizens. For convenience, the checklist, (Appendix E), is available separately.

University of Florida – Institute of Food and Agricultural Sciences References

Fertility Considerations for Sod Production, UF-IFAS, Fact Sheet SL-52

This fact sheet contains information about the macro and micronutrient needs of sod. It also contains recommended rates and scheduling for sod production.

<http://edis.ifas.ufl.edu/pdf/files/SS/SS16400.pdf>

Integrated Pest Management Strategies, UF-IFAS, Circular 1149

This circular describes the principles of integrated pest management (IPM) and advises strategies for implementation.

<http://edis.ifas.ufl.edu/LH080>

Sod Production in Florida, UF-IFAS, Bulletin 260

This bulletin gives an overview of sod production in Florida and contains general information about land preparation, species characteristics, fertilization, irrigation, pest control, and harvesting.

<http://edis.ifas.ufl.edu/LH066>

USDA – Natural Resources Conservation Service References

- (1) Conservation Practice Standard No. 314 (Brush Management)
- (2) Conservation Practice Standard No. 330 (Contour Farming)
- (3) Conservation Practice Standard No. 342 (Critical Area Planting)
- (4) Conservation Practice Standard No. 362 (Diversion)
- (5) Conservation Practice Standard No. 464 (Irrigation Land Leveling)
- (6) Conservation Practice Standard No. 460 (Land Leveling)
- (7) Conservation Practice Standard No. 412 (Grassed Waterway)
- (8) Conservation Practice Standard No. 393 (Filter Strip)

APPENDIX 2. CONTACT INFORMATION

Emergency Reporting

State Warning Point (24hrs.)..... 800-320-0519

Nat'l Response Center (24hrs.) 800-424-8802

Federal law requires the NRC to be immediately notified when a reportable quantity of a hazardous substance is released into the environment.

State Emergency Response Commission
(NOT a 24 hr No.) 800-635-7179

(For state spill reporting requirements. This is for follow-up reporting. In an emergency, call the State Warning Point. If Federal reporting is required, also call the National Response Center.)

Help line numbers for chemical hazard information and regulatory questions

CHEMTREC Hot Line

(Emergency only, 24 hrs) 800-424-9300

SARA Title III help line 800-535-0202

CERCLA / RCRA help line 800-424-9346

Non-Emergency Numbers

Florida Sod Growers

Cooperative, Inc. 863-675-2144

Email: flspdgprwers@aol.com

Web: www.floridasodgrowers.com

FDEP

FDEP Stormwater/Nonpoint Source Management
Section (Tallahassee) 850-245-7513

FDEP Hazardous Waste Management Section
(Tallahassee) 850-245-8705

FDACS

Bureau of Pesticides 850-487-0532

Bureau of Compliance Monitoring ... 850-488-3314

Division of Agriculture and
Environmental Services 850-488-3731

Office of Ag Water Policy..... 850-617-1700
www.floridaagwaterpolicy.com

OAWP Field Offices

West Palm Beach 561-682-2845

Okeechobee..... 863-462-5881

Sarasota..... 800-320-3503

Tampa..... 800-863-0797

Palatka 386-329-4812

Live Oak 800-226-1066

Mariana 850-482-9914

Bartow 863-519-8472

National Pesticide Telecommunications Network
800-858-7378

Provides information on pesticides and pesticide poisonings. (24 hours a day, 365 days a year.)

University of Florida

Pesticide Information Office

(Gainesville) 352-392-4721

Agricultural Law Policy Office

(Gainesville) 352-392-1881

BMP Implementation Teams ... 772-468-3922 x122

USDA, Natural Resources Conservation Service

Gainesville 352-338-9500

web: www.fl.nrcs.usda.gov

Agricultural Mobile Irrigation Labs

Big Cypress Basin (U)

Bill Gaddis

14700 Immokalee Rd.

Naples, FL 34120

Phone: (239)455-4100

FAX: (239)455-2693

E-mail: cswcdmil@yahoo.com

www.collierswcd.com

Lake SWCD (A, N)

Bobby Brown

James Joiner

1725 David Walker Drive, Suite C

Tavares, FL 32778

Phone: (352)343-2481 ext. 6

E-mail: james.brown@fl.nacdnet.net

james.joiner@fl.nacdnet.net

Northwest Florida (A)

Mark Miles

Richele Roberts

2944 Penn Avenue, Suite E

Marianna, FL 32448

Phone: (850) 482-5888

FAX: (850) 482-3988

Email: mark.miles@fl.usda.gov

richele.roberts@fl.usda.gov

Broward SWCD (U)

Richard Naedele

6191 Orange Drive, Suite 6181-P

Davie, FL 33314

Phone: (954)873-7594/(954)584-1306

FAX: (954)792-4919/(954)792-3996

E-mail: richard.naedele@browardswcd.org

Lee County (U)

James (Nik) Nikolich

3434 Hancock Bridge Parkway, Suite 209B

North Fort Myers, FL 33903

Phone: (239)995-5678 x 3

FAX: (239)997-7557

E-mail: nik.nikolich@fl.nacdnet.net

Palm Beach SWCD (U)

David DeMaio
Willie Rojas
750 S. Military Trail, Suite G
West Palm Beach, FL 33415
Phone: (561)683-2285 x 108
FAX: (561)683-8205
E-mail: ddemaio@bellsouth.net
wcrojas01@yahoo.com

Broward EPD (U)

Robert Carew
115 S. Andrews Ave., Room A-240
Ft. Lauderdale, FL 33301
Phone: (954) 519-1281
FAX: (954) 519-1496
E-mail: rcarew@broward.org

Lower West Coast (A, U, N)

Mark Siverling
14700 Immokalee Rd.
Naples, FL 34120
Phone: (239)455-4100
Cell: (239) 961-4292
FAX: (239)455-2693
E-mail: mark.siverling@fl.nacdnet.net

SW Florida Water Mgt. Dist. (A, N)

Joe Mustion
324 8th Avenue West, Suite 104
Palmetto, FL 34221
Phone: (941)729-6804
FAX: (941)722-8133
E-mail: joseph.mustion@fl.usda.gov

Broward/Palm Beach BMP (N)

David DeMaio
Willie Rojas
750 S. Military Trail, Suite G
West Palm Beach, FL 33415
Phone: (561)683-2285 x 108
FAX: (561)683-8205
E-mail: ddemaio@bellsouth.net
wcrojas01@yahoo.com

Manatee County (U)

Jack Tichenor
1303 17th St. West
Palmetto, FL 34221
Phone: (941)722-4524
FAX: (941)721-6608
E-mail: jtichenor@ifas.ufl.edu

PrOMIL (SWFWMD) (A)

Phillip Nathan
P.O. Box 293
Bradenton, FL 34206
Phone: (941)920-2458
FAX: (941)745-5918
E-mail: p.a.nathan@verizon.net

East Central Florida RC&D (U)

Dolly Muñoz
Craig Woods
Dave Devito
4780 Pasco Street
Orlando, FL 32822
Phone: (407)658-7777
E-mail: mil1rcd@cfl.rr.com

Martin SWCD (U)

Charles Lambert
2401 SE Monterey Rd.
(or 2181 East Ocean Blvd.)
Stuart, FL 34996
Phone: (772)221-1303
FAX: (772)221-1300
E-mail: charleslambert@mailcity.com

St. Lucie SWCD (A, U)

Leona Yates (A)
Garry Bailey (U)
8400 Picos Rd., Suite 202
Ft. Pierce, FL 34945
Phone: (772)461-4546 x 111(U), 113(A)
FAX: (772)465-0165
E-mail: leona.yates@fl.nacdnet.net
garry.bailey@fl.nacdnet.net

Floridan RC&D (A, N)

Natural Resources Mgt. Services Inc.
Dick Balduzzi
Cheryl McCrory
1093 A1A Beach Blvd #143
St. Augustine, FL 32080
Phone / FAX: (904)471-1063
E-mail: frcd@comcast.net

Miami-Dade Ag/Urban (A, U, N)

Robert Perez – SDSWCD
Sonny Clayton
1450 N Krome Ave., Suite 104
Florida City, FL 33034
Phone: (305)242-1288
FAX: (305)242-1292
E-mail: rperez@southdadeswcd.org
sonny@southdadeswcd.org

Tampa Bay Estuary (U, A)

Lisa Jannetti
Hillsborough SWCD
201 S Collins Street, Suite 202
Plant City, FL 33563
Phone: (813)759-6450 x 3
FAX: (813)759-6530
E-mail: lisa.jannetti@fl.nacdnet.net

U = Urban Lab
A = Agricultural Lab
N = Nursery Lab

APPENDIX 3. GLOSSARY

Adsorbed – Adhesion to a surface in a thin layer.

Conveyance capacity – The amount of flow (generally expressed in cubic feet per second) that a canal/ditch can carry based on the size, shape, slope, and condition of the canal/ditch.

Denitrification – Microbial conversion of nitrate to gasses (N₂ and N₂O) under anaerobic conditions.

Diluent – A diluting substance.

Eutrophication – A condition where a water body is characterized by an overabundance of nutrients that feed a dense growth of algae and other organisms, and often results in oxygen depletion of the water body as the algae decays.

Evapotranspiration – The combined process of water evaporation and the loss of water from plants.

Fallow - To be left uncultivated or unplanted.

Hydrologic conditions – The status of water-related parameters in an area; those parameters are typically rainfall, and water levels above (ponds/lakes/reservoirs) and below (aquifers) ground.

Landward – Inland of the high water line of a stream or waterbody.

Lateral flow – The movement of water below ground along or parallel to a soil layer.

Perennial – Appearing every year.

Rinsate - Any solution containing pesticide residue which is generated from washing or flushing of pesticide containers and pesticide equipment.

Rip-rap – Large, loose angular stones that serve as a permanent erosion-resistant ground cover.

Riparian – Belonging or relating to the bank of a river or stream; of or on the bank.

Scout – Routinely monitoring fields, borders, and adjacent vegetation for insects and disease activity.

Signs – Evidence of disease in plants as indicated by the presence of disease-producing organisms or of any of their parts.

Soil water tension – The magnitude of the suction (negative pressure) the plant roots have to create to free soil water from the attraction of the soil, and move it into the root cells.

Spoil – The soil material obtained from excavating an area to construct such works as canals/ ditches and/or ponds. This material is typically used to build berms and/or dikes along or in the vicinity of the excavation site.

Symptoms – Evidence of disease in plants as expressed by the reaction of the plants to the presence of the irritating factor or organism.

Topographic maps – Detailed, graphic representation of the land surface elevations of a region.

Treatment train – A combination of best management practices picked because they work best with the characteristics of the site and are best suited to achieving the storm-water quality and quantity goals.

Uncoated sands – Sand particles that lack clay and organic matter coating, and have poor water and nutrient holding capacities.

APPENDIX 4. SOIL AND TISSUE TESTING INFORMATION

Soil Testing

Often the benefits of a soil test are assumed. The soil testing process comprises four major steps and understanding each one clearly will increase the reliability of the process tremendously. The steps in the soil testing process are:

- soil sampling
- sample analysis
- interpretation of test results
- nutrient recommendations

Soil Sampling:

- ✓ Divide your farm into areas for sampling. Separate sample areas with different crop growth, history or patterns, soil color, or lime or fertilizer histories. The sample you collect should represent the average for a uniform portion of the area sampled, and should be taken in a consistent fashion each year.
- ✓ Use the proper sampling tools, such as a sampling tube or soil auger. If it is necessary to use a shovel or trowel, dig a V-shaped hole in the soil and slice a small slab from one side of the hole.
- ✓ Identify samples by letter or number and keep a record of where the samples were taken.
- ✓ Use a competent soil testing laboratory that uses calibrated soil test methodologies. Not all laboratories can provide accurate fertilizer recommendations for Florida soils. The Mehlich-1 soil test has been calibrated for sandy soils in Florida.

Soil samples need to be representative of the field and soil types and the soil analysis results will be only as good as the submitted sample is. Samples collected from areas that differ from typical characteristics of the farm should be submitted separately and should not be consolidated with the primary samples. Using a management zone (area on the farm that is managed similarly) as a guiding factor to collect and consolidate samples is strongly recommended to optimize resources. Consult the IFAS Extension Fact Sheet SL181 for further information on soil sampling strategies.

Sample Analysis:

The soil samples that are submitted to the testing laboratories undergo a series of physical and chemical processes that are specific to the soil types, crops, and management regimes. Once the

soil samples are homogenized through grinding and/or sieving, a precise volume of the sample will be extracted for plant nutrient through an extraction procedure. The following standard methods are followed at the IFAS Soil Testing Laboratories for different soils in Florida:

- a) Mehlich-1 extraction - this method is performed on all acid-mineral soils up to a soil pH of 7.3.
- b) AB-DTPA extraction - this method is performed on alkaline (calcareous) soils with a pH of 7.4 and above.
- c) Water extraction - this method is used for extraction of P in all organic soils.
- d) Acetic acid extraction - this method is performed on all organic soils for extraction of K, MG, Ca, Si, and Na.

It is extremely important that procedures used at the laboratories are well understood before submitting the samples since most BMPs are tied to the standardized procedures used by the labs at the land-grant universities in the state such as UF/IFAS. Similarly, it is also very important to note that the IFAS laboratory does not offer any test for N since there is no reliable test for plant available N under Florida conditions. N recommendations are based on crop nutrient requirements found in the research literature. More information regarding the procedures used at the IFAS Extension Soil Testing Laboratory in Gainesville can be found in the extension publication, Circular 1248.

Interpretation of Test Results:

The primary goal of state laboratories in offering the soil testing service is to provide interpretation of the soil test results based on soil test-crop response trials and field calibration of the test results with the optimum economic yields of the various plant species. Economic yield increases resulting from added nutrients cannot be obtained once the test results are interpreted as 'High' resulting in no recommendation for that particular nutrient. The interpretations provided are specific to the soil and plant species.

Current interpretation tables can be obtained from SL 189 - IFAS extension fact sheet.

Nutrient Recommendations:

To reiterate, nutrient recommendations based on soil test results are formulated based on the opti-

mum economic crop response to an added nutrient to the soil.

Tissue Testing

Tissue testing is the analysis and diagnosis of the plant's nutritional status based on its chemical composition. It is commonly performed as analyses on dried blades, leaves or dried petioles or on sap from fresh petioles, with results compared to recommended nutrient ranges.

Efficient fertilizer management is important to reduce costs, conserve natural resources, and to minimize potential impacts on the environment. These goals can be achieved through optimum management of the fertilizer component. Timely tissue testing is an important tool used in fertilizer management through monitoring the plant's nutritional status, and such testing is also used in diagnosing suspected problems like nutritional deficiency, toxicity or imbalance. As a management tool, tissue testing can increase a grower's return by preventing deficiencies that can reduce yield(s), market quality, and profitability.

Methodology:

Begin sampling soon after the crop is established and continue at regular intervals (weekly or biweekly). Individual plants, even side-by-side, may have different nutritional status. Therefore, by sampling a sufficiently large number of plants, the effect of this error due to inherent variability should be minimized. It is preferable to include a soil sample together with a tissue sample when submitting samples to a diagnostic lab, since the soil sample may indicate other factors - such as pH - that may influence crop growth, nutrient availability, and uptake. Avoid plant tissue testing if the field has received foliar nutrient sprays containing micronutrients or nutrient-containing pesticides. Also, avoid sampling plants damaged by pests, diseases, or other chemicals when trying to monitor the nutritional status of the sod.

Whole-leaf sampling will be most useful early in the season, while later in the season, it can help to point to changes in fertilization practices that are needed for the next season. Fresh petiole sap testing for N and K, practiced regularly throughout the season, can help manage the current crop as well as provide guidance for the next crop. Sample a recently matured leaf blade. Collect enough leaf material so that the sample is representative of the crop stand, and that the sample is large enough to perform the required analyses.

If a deficiency is suspected, collect one composite sample from the area exhibiting the disorder and a second sample from an otherwise "normal" section for comparison when trying to diagnose a nutrient deficiency. Separate and properly label the "disorder" sample and the "normal" sample in order to make a valid comparison after analyses. Keep notes on condition of the sod and stage of growth, weather, and other variables for future reference.

Be careful not to crush or damage samples during cleansing. Avoid using tap water to rinse blade samples, since it can be high in nutrients such as calcium, iron, magnesium, or sulfate sulfur. Use distilled water instead. In most situations, cleansing is not needed. Blot the samples dry with absorbent paper after rinsing, and air-dry the samples several hours before shipment. Wrap the samples in absorbent paper and place them in a large envelope if a plant analysis kit is not available, and mail immediately.

Select a reputable laboratory that provides interpretations and recommendations based upon test results, which are appropriate for your growing region. Interpretation guidelines should be based on actual field research, not on "typically observed" or historical lab databases. The laboratory should be reliable and accredited and also offer a routine turnaround of less than 48 hours.

For more information please see SL 131, Plant Tissue Information Sheet, Soil and Water Science Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Last revised July 2005.

<http://edis.ifas.ufl.edu/SS182>.

References:

- Sartain, J.B. 2001. Soil Testing and Interpretation for Florida Turfgrasses. SL181. Soil and Water Science, Cooperative Extension Service. IFAS, p. 2.
<http://edis.ifas.ufl.edu/SS317>.
- Mylavarapu, R.S. and E.D. Kennelley. 2002. UF/IFAS Extension Soil Testing Laboratory Analytical Procedures and Training Manual. Soil and Water Science, Circular 1248, Cooperative Extension Service, IFAS, <http://edis.ifas.ufl.edu/SS312>.
- Mylavarapu, R.S. 2002. The Process of Standardized Nutrient Recommendation Development for Successful Crop Production and Environmental Protection. SL 189, Soil and Water Science, Cooperative Extension Service, IFAS.
<http://edis.ifas.ufl.edu/SS401>.

APPENDIX 5. INCENTIVE PROGRAMS FOR QUALIFYING FARMS

The implementation of Best Management Practices can reduce non-point sources of pollution, conserve valuable soil and water resources, and improve water quality. The implementation of these management practices can also be expensive and, in some cases, may not be economically feasible for agricultural producers. To reduce the financial burden associated with the implementation of selected practices, several voluntary cost-share programs have been established. These programs are designed to conserve soil and water resources and improve water quality in receiving water bodies. The narrative below is intended to provide basic information regarding the primary federal, state, and regional cost-share programs. Sources of additional information have also been included, and growers are encouraged to contact the identified agencies or organizations for current information about each program.

I. Programs Administered by USDA - Farm Services Agency (FSA)

Conservation Reserve Program (CRP) This program encourages farmers to convert highly erodible cropland or other environmentally sensitive lands to vegetative cover including grasses and/or trees. This land use conversion is designed to improve sediment control and provide additional wildlife habitat. Program participants receive annual rental payments for the term of the contract in addition to cost share payments for the establishment of vegetative cover. CRP generally applies to highly erodible lands and is more applicable to North Florida.

Conservation Reserve Enhancement Program (CREP) CREP uses a combination of federal and state resources to address agricultural resource problems in specific geographic regions. This program (which is not limited to highly erodible lands) is designed to improve water quality, minimize erosion, and improve wildlife habitat in geographic regions that have been adversely impacted by agricultural activities.

For further information on CRP and CREP, including eligibility criteria, please contact your local USDA Service Center. Information is also available on the Internet at www.fsa.usda.gov.

II. Programs Administered by USDA - NRCS

Environmental Quality Incentives Program (EQIP) EQIP provides financial assistance (generally up to 75 percent cost share) to farmers for the implementation of selected management practices. Eligibility for the program requires that the farm have a NRCS approved Conservation Plan. Practices eligible for EQIP cost share are designed to improve and maintain the health of natural resources and include water control structures, conversion of seep to overhead irrigation systems, nutrient management and other erosion control measures. The 2002 Farm Bill made numerous improvements to the program and significantly increased available funding.

Emergency Conservation Program (ECP): The ECP provides financial assistance to farmers and ranchers for the restoration of farmlands on which normal farming operations have been impeded by natural disasters. More specifically, ECP funds are available for restoring permanent fences, terraces, diversions, irrigation systems, and other conservation installations. The program also provides funds for emergency water conservation measures during periods of severe drought.

Small Watershed Program (PL-566) The Small Watershed Program works through local government sponsors to help participants solve natural resource problems in watersheds of 250,000 or fewer acres. Technical and financial assistance is available for flood prevention, sediment control, water supply, water quality, fish and wildlife habitat enhancement, and wetlands creation and restoration.

Wetlands Reserve Program (WRP) WRP is a voluntary program designed to restore wetlands. Program participants can establish easements (30-year or perpetual) or enter into restoration cost-share agreements. In exchange for establishing a permanent easement, the landowner usually receives payment up to the agricultural value of the land and 100 percent of the wetland restoration cost. Under the 30-year easement, land and restoration payments are generally reduced to 75 percent of the perpetual easement amounts. In exchange for the payments received, landowners agree to land use limitations and agree to provide wetland restoration and protection.

Wildlife Habit Incentives Program (WHIP)

The Wildlife Habitat Incentives Program provides financial incentives for the development of fish and wildlife habitat on private lands. Program eligibility requires that landowners develop and implement a Wildlife Habitat Development Plan. Participants enter multi-year (5 to 10 year) agreements with USDA-NRCS.

For further information on these programs, including eligibility criteria, please contact your local USDA Service Center. Information is also available on the Internet at the following web site: www.nrcs.usda.gov

III. Programs Administered by State and Regional Entities:

Soil and Water Conservation Districts

In order to assist agricultural producers in the implementation of BMPs, the Florida Department of Agriculture and Consumer Services has executed a number of cost-share contracts with several of the state's Soil and Water Conservation

Districts and Resource Conservation and Development Councils, Inc. Many of these cost-share contractors administer cost-share programs using *Applicant's Handbooks* which include reimbursement rates and grower selection criteria.

Water Management District Cost Share

Memoranda: The Department of Agriculture and Consumer Services has executed Memoranda of Agreement (MOA) with certain Water Management Districts to provide coordination for BMP cost-share programs. Each MOA will identify the primary program areas within the District's geographical boundaries, and designates the agency responsible for program administration.

For further information on these programs, including eligibility criteria, please contact your local Water Management District, Soil and Water Conservation District or the Florida Department of Agriculture and Consumer Services. Information and links to other sites are also available on the Internet at the following web site: www.floridaagwaterpolicy.com

APPENDIX 6. EXAMPLE RECORD KEEPING FORMS

Producers are required to keep accurate records to document BMP implementation. Record keeping also aids producers in operating and maintaining BMPs. The tables below correspond to all the mandatory record-keeping requirements contained in this manual. They serve as both a reference sheet and a set of templates to develop your own record-keeping system. You may maintain your records as hard copies or in an electronic format, depending on your preference. You may use these tables or choose commercially available record-keeping software suited to your commodity. However, at a minimum, your records should include the information categories in these tables.

Soil Sample Records				
Date	Field Location	# of Samples	Name of Lab	Records Location

Tissue Sample Records				
Date	Field Location	# of Samples	Name of Lab	Records Location

Fertilization/Nutrient Records						
Date	Location	Acreage Covered	Type ¹	Formulation ²	Grade ³	Rate (Lbs/Acre)

Rainfall (in.)											
Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.

¹ Organic, Inorganic, Chemical

² Granular, Water Soluble, etc.

³ e.g. 10-10-10

Well Records					
Location	Year Constructed	Constructed By	Last Modified	Modified By	Records Location

Irrigation Events				
Date	Location	Amount Applied (Gal.)	Run Time (Hr.)	Conditions ¹

Irrigation Maintenance							
Date	Location	Last Inspected	Motor Values ²	Withdraw Rate (GPM)	Pump Values ³	Current System Efficiency ⁴	Records Location

Crop Yield and Rotations			
Season	Location	Crop	Yield

Integrated Pest Management							
Date	Location	Acreage Covered	Crop	Total Amount ⁵	Formulation ⁶	Pesticide Class ⁷	Pest Targeted ⁸

¹ Temperature, Wind Speeds, Cloud Cover, Time of Day ² Energy Consumption (KwH) and Motor Amperage (Amps)

³ Discharge Rate (GPM) and PSI (lb/in²) ⁴ Source Withdraw vs. Crop Available (V₁:V₂) ⁵ Lbs/ac, gal/ac, etc.

⁶ Dry, Liquid, Aerosol ⁷ Nematicide, Fungicide, etc. ⁸ Be Specific, e.g. Thrips



ADAM H. PUTNAM
COMMISSIONER

Florida Department of Agriculture and Consumer Services
Office of Agricultural Water Policy

FDACS—OAWP
1203 Governor's Sq. Blvd.
Suite 200
Tallahassee, FL 32301

**NOTICE OF INTENT TO IMPLEMENT
WATER QUALITY/QUANTITY BMPS FOR FLORIDA SOD**

Rule 5M-9.004, F.A.C.

- **Submit a separate NOI for each county in which you are enrolling property.**
- Submit this **Notice of Intent to Implement (NOI)**, along with the **BMP Checklist**, to the Florida Department of Agriculture and Consumer Services (FDACS), as provided below.
- **Keep a copy of the NOI and the BMP Checklist in your files.** These documents must be completed, maintained, and available for inspection by FDACS, as one of the conditions for a presumption of compliance with state water quality standards. A submitted NOI and checklist are also required to be eligible for some sources of BMP cost-share funding.

If you would like assistance in completing this NOI form or the BMP Checklist, or in implementing BMPs, contact FDACS staff at (850) 617-1727 or AgBmpHelp@freshfromflorida.com.

Mail or fax this completed form and the BMP Checklist to: **FDACS Office of Agricultural Water Policy**
1203 Governor's Square Boulevard, Suite 200
Tallahassee, Florida 32301
Fax: (850) 617-1701

☐ Landowner or ☐ Leaseholder Information

Name: _____

Mailing Address: _____

City: _____ State: _____ Zip: _____

Telephone: _____ FAX: _____

Email: _____

Authorized Contact Information

NOTE: If the Authorized Contact is the same as the landowner/leaseholder listed previously, please check:

☐ **Same as above.** If not, complete the authorized contact information below.

Name: _____

Mailing Address: _____

City: _____ State: _____ Zip: _____

Telephone: _____ FAX: _____

Email: _____

Complete the following information for the property associated with this NOI.
You may list multiple parcels located within the same county.

Farm Name(s): _____

County: _____

Total Acres on which BMPs will be implemented: _____

Tax Parcel Identification Number(s) from County Property Appraiser

Please submit a copy of your county tax bill(s) for the enrolled property, with your name, address, and the tax parcel ID number(s) clearly visible. If you cannot provide a copy of your tax bill(s), please write the tax parcel ID number(s) below in the format the county uses.

Parcel No.: _____

Parcel No.: _____

Parcel No.: _____

(If necessary, use an additional sheet to complete your list of parcel identification numbers within the county.)

All or part of this property is already enrolled by me or a previous owner/operator under one or more existing NOI(s) in a FDACS BMP program.

☐ Yes - Program(s): _____

Enrolled Owner/Operation: _____

☐ No, not already enrolled ☐ I don't know whether it is already enrolled

In accordance with section 403.067(7)(c)2, Florida Statutes, I submit the foregoing information and the BMP Checklist as proof of my intent to implement the BMPs applicable to the parcel(s) enrolled under this Notice of Intent.

Print Name: _____

☐ Landowner ☐ Leaseholder ☐ Authorized Agent (check one)

Signature: _____ Date: _____

Name of IFAS or FDACS Staff Assisting with NOI: _____

NOTES:

1. You must keep records of BMP implementation, as specified in the BMP manual.
2. Please remember that it is your responsibility to stay current with future updates of this manual. Visit the following website periodically to check for manual updates: www.floridaagwaterpolicy.com.
3. You must notify FDACS if any of the following circumstances occur with regard to the parcel(s) enrolled under this NOI:
 - a. Full or partial change in ownership following a real estate transaction
 - b. Change in BMPs or BMP implementation schedule, including non-implementation of BMPs

FLORIDA SOD WATER QUALITY/QUANTITY BMP CHECKLIST

Instructions:

1. Refer to the manual and check "yes" for each BMP that you are currently practicing and will continue to practice.
2. For those BMPs that you plan to implement in the near future, enter the year you plan to implement them in the "Planned" column.
3. If a BMP is not applicable to your operation, check N/A. For BMPs you will not implement, check all of the following that apply under "No": TNF = technically not feasible, ENF = economically not feasible, or "Other". Explain checkmarks entered under the "Other" in the comments section at the end of this form.
4. According to FDACS rule, applicable nutrient management practices (1.0) must be implemented as soon as practicable after submittal of the Notice of Intent (NOI). All other BMPs identified in the NOI should be implemented as soon as practicable within the first year after the NOI is submitted.
5. Submit this BMP Checklist with your Notice of Intent (NOI) form, and keep a copy in your files.

	Yes	Planned	No (check reason below)			
BMP # / BMP Group (see body of manual for full description)	Check below	Enter Year	NA	TNF	ENF	Other*

1.0 Nutrient Management

1.1. Soil and Tissue Testing BMPs

1. Use Mehlich-1 soil test results or equivalent to determine P application rate						
2. Use tissue testing to determine need for supplemental fertilizer application						

1.2. Standard Fertilization Practice BMPs

1. Target fertilizer using table on page 14						
2. Calibrate fertilizer equipment properly						
3. Use split applications						
4. Avoid soluble N > 50 lbs/acre/application and <20 lbs on ribbons						
5. Fertilizer loading activities conducted in proper areas						
6. Supplemental N for leaching rain events						

1.3. Special Fertilizer Application BMPs

1. Micronutrients applied when deficiencies exist						
2. Special P management for uncoated sands						
3. CRF used around sensitive areas						
4. Fertigate only after sod has pegged or advanced to inter-ribbon						

1.4. Other Fertilizer Sources

1. Adjust fertilizer rates when using reclaimed water						
2. Adjust fertilizer rates when bio-solids are used						

2.0 Irrigation Scheduling

2.1. Monitoring Soil and Plant Water Status

1. Determine soil moisture content						
------------------------------------	--	--	--	--	--	--

* Please enter "other" reasons for not implementing BMPs in the space provided at the end of the checklist.

	Yes	Planned	No (check reason below)			
BMP # / BMP Group (see body of manual for full description)	Check below	Enter Year	NA	TNF	ENF	Other*
2. Test and calibrate soil moisture equipment						
2.2. Forecasting Crop Water Needs						
1. Manage irrigation and fertilization together						
2. Determine evapotranspiration levels						
3. Determine irrigation application amounts						
2.3. Irrigation Scheduling						
1. Base events on rainfall, soil capacity, and growth stage.						
2. Minimize application losses by early A.M. or late P.M. irrigation						
3. Maintain water table at lowest level for sub-irrigation						
4. Irrigate establishment fields and ribbons appropriately						
3.0 Irrigation System Maintenance and Evaluation						
3.1. General Irrigation Maintenance						
1. Determine system operating values and efficiency range						
2. Check irrigation system uniformity periodically						
3. Establish a maintenance schedule						
4. Test water quality annually						
3.2. System Specific Irrigation Maintenance						
1. Inspect and replace sprinkler nozzles						
2. Maintain high pump station efficiency						
3. Clean and maintain ditches and water control structures						
4. Maintain land level design grade						
4.0 Sediment and Erosion Control Measures						
4.1. Filter Strip Design and Construction						
1. Use filter strips if needed						
4.2. Silt Screens Design and Construction						
1. Use silt screens (less than 3 months) for sheet flow						
2. Install silt screens properly						
4.3. Sediment Traps Design and Construction						
1. Install traps within conveyance system						
2. Retrofit associated structures with flashboard risers						
4.4. Sediment Basin Designs and Construction						
1. Storage capacity \geq sediment volume						
2. Provide emergency drainage						
3. Design for 10-year storm event						
4.5. Chemical Soil Amendments						
1. Use PAM in non-vegetated areas						
2. Conduct jar tests with supplier						
3. Adjust application rates based on soil properties						

* Please enter "other" reasons for not implementing BMPs in the space provided at the end of the checklist.

	Yes	Planned	No (check reason below)			
BMP # / BMP Group (see body of manual for full description)	Check below	Enter Year	NA	TNF	ENF	Other*
4. Use correct application technique						

5.0 Integrated Pest Management

5.1. Planning Steps for an IPM Program

1. Identify key pests and life cycles						
2. Select preventive cultural practices						

5.2. Specific IPM Practices

1. Use qualified scouts and monitor pest and disease activity						
2. Select pesticides for target pests and rotate accordingly						
3. Spray at night for certain pests						
4. Use less toxic products around water						
5. Coordinate applications with atmospheric and soil conditions						

5.3. Mix-Load Activities

1. Store products in proper facility > 100' from waters						
2. Use appropriate mix/load activities						
3. Dispose of containers appropriately						

6.0 Wellhead Protection

6.1. Well Planning

1. Review local comprehensive plan						
2. Research permit needs						
3. Cap or valve free flowing wells						
4. Construct new wells upgradient						

6.2. Well Drilling and Operation

1. Use a licensed water well contractor						
2. Follow shallow well construction specifications						
3. Follow pad and casing specifications						
4. Use backflow prevention devices						

7.0 Wetlands and Springs Protection

7.1. Wetland Protection and Impact Avoidance

1. Identify wetlands using soil survey						
2. Eliminate or reduce adverse impacts to wetlands						
3. Maintain 25 foot upland buffer from watercourses						
4. Maintain 15 foot upland buffer from isolated wetlands						

7.2. Water Quality Treatment and Field Discharges

1. Use a treatment train system						
2. Use sediment sumps on steep slopes with history of erosion						
3. Use swales to encourage sheet flows						

7.3. Special Criteria for First and Second Magnitude Springs Basins

* Please enter "other" reasons for not implementing BMPs in the space provided at the end of the checklist.

	Yes	Planned	No (check reason below)			
BMP # / BMP Group (see body of manual for full description)	Check below	Enter Year	NA	TNF	ENF	Other*
1. Maintain 100 foot upland buffer around spring features						
2. Implement a written nutrient and irrigation management plan						
3. Use CRF or split applications on contributing areas						

8.0 Ditch Construction and Maintenance

8.1. Planning and Design

1. Use technical resources to plan ditch system						
2. Avoid hydraulic drawdown impacts to wetlands						

8.2. Ditch Construction

1. Construct ditches consistent with soil type						
2. Follow appropriate plans and grades						
3. Use temporary erosion controls during construction						
4. Stabilize bare soils and newly constructed ditch banks						
5. Maintain adequate field drainage with lateral ditches and grassed waterways						

8.3. Systematic, Routine, and Custodial Maintenance

1. Routinely remove sediment from ditches						
2. Maintain permanent vegetative cover and control broadleaves						
3. Use structural control measures in high water velocity areas						
4. Keep records of ditch cross sectional area						

8.4. Floating Aquatic Weed Control

1. Remove aquatic weeds at water control structures						
2. Control problem aquatic weeds						

9.0 Conservation Buffers

9.1. Field Border Design and Construction

1. Plan and design field borders for equipment turning						
2. Locate and optimize field borders						
3. Assess the need for berms to redirect concentrated flows						
4. Plant borders using native species						

9.2. Riparian Buffer Design and Construction

1. Install riparian buffer if > 1% slope						
2. Include zone 1						
3. Include zone 2						
4. Locate crossings to minimize impacts to buffers						
5. Use USDA-NRCS riparian buffer specifications						
6. Use native shrubs and trees in buffers						

* Please enter "other" reasons for not implementing BMPs in the space provided at the end of the checklist.

BMP # / BMP Group (see body of manual for full description)	Yes	Planned	No (check reason below)			
	Check below	Enter Year	NA	TNF	ENF	Other*
10.0 Stormwater Management						
10.1. Stormwater Management Planning and Implementation						
1. If stormwater problems exist develop a written plan						
2. Operate and maintain your stormwater system						
3. Adjust plan to render it effective						
11.0 Access Roads						
11.1. Road Planning						
1. Plan road location using technical resources						
2. Use 25 foot setbacks from wetlands for elevated roads						
3. Maintain a turnaround area at dead end roads						
11.2. Road Construction and Drainage						
1. Construct during dry conditions and use pervious materials						
2. Balance cuts and fills						
3. Minimize road widths consistent with vehicle use						
4. Keep slope on shoulders < 2:1						
5. Maintain pre-development hydrologic conditions						
6. Do not exceed 10% grades and slope roads toward fields						
7. Stabilize soils to prevent erosion around culverts						
12.0 Mowing Management						
12.1. Mowing						
1. Use mowing equipment tailored to variety and conditions						
2. Establish a mowing schedule						
3. Properly dispose of clippings						
13.0 Seasonal Farming Operations						
13.1. Crop Planning and Design						
1. Plan production based on variety and soil conditions						
2. Select cover crops to add organic matter to soil						
3. Know the carbon to nitrogen ratio of incorporated residue						
13.2. Fallow Requirements and Field Abandonment						
1. Use a three year rotation interval						
2. Use appropriate wetland setbacks						
3. Restore surface water features to pre-development						
13.3. Clippings Management						
1. Adjust mowing height and mow bahia 3-4 in						
2. Rake clippings if clumping occurs						
3. Place clippings in upland area with < 3% slope						
4. Compost or feed clippings to livestock						

* Please enter "other" reasons for not implementing BMPs in the space provided at the end of the checklist.

Please enter "other" reasons below for not implementing BMPs.

[illegible]