

Implementation and Verification of BMPs for Reducing P Loading from the Everglades Agricultural Area

2007 Annual Report



**Submitted to the
Everglades Agricultural Area Environmental Protection District
And
The South Florida Water Management District**

By

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EXECUTIVE SUMMARY

In March 2005, the South Florida Water Management District (SFWMD) approved a modification of the EAA-EPD Scope of Work (SOW). In the revised SOW new tasks were proposed for BMP research, testing and implementation. The tasks and objectives of this SOW are: 1) Statistical Evaluation of BMP Monitoring and Research Data with an objective to assess parameters that affect farm P discharge, to improve selection and application of existing BMPs; 2) BMP Outreach Consultation Program: a one-on-one consultation program on priority farm basins with an objective of enhancing the dissemination and implementation of BMPs to all growers in the EAA basin; and 3) Other Outreach and extension activities that include BMP training seminars and workshops and development and transmittal of extension publications on BMP implementation in the EAA.

The success that the BMP program has achieved since the inception of the program may be influenced by the constant changes that this area is currently experiencing and those expected for the future including the increased levels of P in Lake Okeechobee water used for irrigation on EAA farms, the decline in the acreage planted to sugarcane and the associated increase in the acreage to less water tolerant and/or higher P demanding crops. Thus, under these uncertainties that the EAA basin is facing, the importance of proper and uniform BMP implementation across the entire basin becomes more crucial to ensure the continued success of the BMP program in the Glades area.

This annual report documents the progress and achievements of the BMP Consultation Program, and the outreach and extension activities of this project: "Implementation and Verification of BMPs for Reducing P Loading from the Everglades Agricultural Area", described in the 2006/ 2007 Scope of Work for the UF/IFAS with the Everglades Environmental Protection District of the Everglades Agricultural Area (EAA-EPD). The results and conclusions of the detailed statistical analysis will be published in a separate extensive report in August 2007. Major accomplishments of the BMP Consultation Program and the outreach and extension activities are summarized below:

Farm BMP Consultation Program:

The program consists of individual farm visits by UF/IFAS personnel to each farm basin in the EAA and discussions of BMP implementation with farm personnel with an objective of enhancing the performance and implementation of BMPs by all growers in the EAA basin. During the second year of the farm BMP consultation program, the efforts have

concentrated on farm basins in the S-6 sub-basin. However, some remaining farm basins from the S-5A and some farm basins from the S-7 sub-basin were also visited during this period. This year we have implemented on-farm BMP training (in English and/or Spanish as needed) in conjunction with the consultation program. These changes have resulted in better and more interaction between UF/IFAS personnel and farm personnel. Most common suggestions to growers included sediment removal from canals, floating aquatic weed control, modified pumping practices and more complete BMP implementation documentation. We have also initiated a post-visit survey to assess the benefits of the program and the degree of implementation of recommendations. Some preliminary encouraging results are presented in the report.

The BMP consultation program in its second year has been very successful in reaching out to the growers in the EAA. Farmers contacted are willing to participate, listen, and consider making changes to their practices. Growers have also voiced their concerns including the impact of Lake Okeechobee irrigation water quality in the last few years on the P loads coming out of the farms and the maintenance and cleaning of some secondary SFWMD canals. A copy of a BMP consultation program checklist and an evaluation form are included in **Appendix A**.

BMP Training workshops:

Best Management Practices workshops have been designed by UF/IFAS faculty to cover all major topics of the BMP program to insure uniform and successful implementation by EAA growers. The topics covered included a review of Rule 40E-63, wise-use of the pesticides including Atrazine and Ametryn, BMP point system overview, soil testing and plant tissue analysis, fertilizer application BMPs, rainfall detention, sediment controls, and particulate P research. Seven workshops were conducted. In addition, all presentation materials presented during the BMP workshops are now available in Spanish and are used in on-farm BMP training. A copy of BMP all presentations translated to Spanish are included in **Appendix B**.

BMP Extension Materials:

Three extension publications were translated to Spanish and published online at the University of Florida extension website UF/EDIS <http://edis.ifas.ufl.edu> . These publications are included in **Appendix C**.

INTRODUCTION

The EAA basin is highly productive agricultural land comprised of rich organic peat and muck soils located south of Lake Okeechobee and north of the Water Conservation Areas (WCAs). The EAA plays an important role in the Everglades water supply, either directly through agricultural drainage runoff or indirectly by serving as a conduit for large water transfers from Lake Okeechobee to the WCAs. The primary mode of drainage in the EAA is by groundwater flow, which may be by capillary action through the organic soils, or through fractures in the marl-soil interface. On-farm water management is achieved by using this groundwater flow and the level in open field ditches to raise or lower the field water tables. Rainfall is highly seasonal and frequently intense. Nearly all drainage discharge is achieved by pumping through high volume, low head, axial-flow pumps. Drainage water from the EAA, after treatment in Storm Treatment Areas (STAs), is ultimately discharged to the downstream WCAs, Everglades National Park (ENP), or the South Florida coastal estuaries. Agricultural drainage waters discharged from the EAA are nutrient-enriched compared to the original flow under which the Everglades evolved. This nutrient enrichment, specifically phosphorus (P), has been cited as one of the possible causes of changes in the ecosystems of the WCAs and the ENP (Whalen et al., 1992; Sievers et al., 2003). Concerns regarding the impact of the nutrient laden rich waters from the EAA on the fragile ecosystems of the Everglades Protected Areas prompted the state of Florida to enact the Everglades Forever Act (EFA) in 1994. The EFA mandated the South Florida Water Management District (SFWMD) to create and administer the Everglades Regulatory Program, Chapter 40E-63, F.A.C., which oversees and monitors the implementation of BMPs to reduce P loads from farms in the EAA basin.

The EAA as a whole is required by the EFA to achieve a P load reduction of 25 percent or greater relative to a rainfall adjusted baseline P load average (October 1978 - September 1988). Since January 1, 1995, BMP implementation has been mandatory for all farms that discharge water into SFWMD canals. The SFWMD monitors EAA basin P loads via a network of monitoring stations that border the EAA. The EAA basin has exceeded the minimum requirement of 25 percent reduction in TP load during the eleven years since the BMP program was fully implemented, averaging more than 50 percent per year. This reduction is equivalent to 1,734 mt of TP prevented from leaving the EAA basin as a runoff (Van Horn et al., 2007). In addition to the implementation of a suite of BMPs specifically designed for this area, each farm monitors daily rainfall, flow, and total P concentration at all

discharge points, which is submitted to the SFWMD as required by each farm's BMP program.

The success of the BMP program in the EAA is a direct result of the overall participation of all the interested parties, the grower's willingness to succeed, the enforcement of BMP implementation by the SFWMD, the economic incentive in the form of Agricultural Privilege Tax, and the educational and research support from UF/IFAS. Since the success of the BMP program in the EAA is in part due to a continuous effort to update and refresh grower knowledge of effective BMP implementation, new methods that target improving BMP implementation and performance warrant evaluation. Previous educational efforts have mainly relied on grower participation in BMP training workshops conducted by UF/IFAS researchers. Water managers, grower representatives, and researchers suggested that further improvements in BMP performance in the EAA could be achieved by providing direct, on-farm BMP consultation services to all growers.

The BMP consultation program has a goal of appraising and consulting cooperatively with each farm basin of the EAA within a five year period. The BMP program will be evaluated via grower feedback through a BMP survey and by tracking the progress of recommendations provided to a given sub-basin. Simultaneous with the BMP consultation program is an effort by UF/IFAS researchers to update and complete an online set of publications that explain to growers the rationale and techniques of each BMP recommended by the SFWMD for the EAA. This year the online BMP extension publications were also translated to Spanish to better inform the Spanish speaking community of the EAA.

The Everglades Regulatory Program, Chapter 40E-63, F.A.C. ("Rule 40E-63") mandates landowners in the EAA to sponsor a program for BMP research, testing and implementation. The University of Florida's Institute of Food and Agricultural Sciences has conducted a comprehensive research program regarding BMP effectiveness, testing, and implementation since 1992 under the Everglades Agricultural Area-Environmental Protection District (EAA-EPD) BMP Master Permit Scope of Work. In March 2005, the SFWMD approved a modification of the EAA-EPD Scope of Work (SOW) required for the BMP research portion of the Master Permit for the EAA. In the revised SOW new tasks were proposed for BMP research, testing and implementation. Some of the tasks and objectives of this SOP are:

Implement a BMP Consultation Program: A one on one BMP consultation program that covers all farm basins with an objective of enhancing the dissemination and implementation of BMPs to all growers in the EAA basin. This outreach program targets all sub-basins and farms and attempts to complete all farm sub-basins within the EAA basin within a five year period.

Conduct Outreach and Extension Activities: Continue to provide BMP training seminars and workshops to all growers in the EAA as part of the requirements in their individual BMP permits to train farm personnel on BMP practices. Also to develop and publish extension materials and documents that explains to growers the BMPs in the EAA.

GOAL AND OBJECTIVES

The goal of the Farm BMP Consultation Program is to develop a closer relationship between the grower and UF/IFAS through individual farm visit to exchange information to improve BMP implementation and performance at their farms. This report documents the progress of the following specific tasks and objectives of this research and education program:

Task 1: Farm BMP Consultation Program: An intensive one-on-one consultation Program that consists of individual farm visits by UF/IFAS personnel to each farm basin in the EAA and discussions of BMP implementation with farm personnel.

Objective: Enhance the performance and implementation of BMPs by all growers in the EAA basin. This outreach program targets all farmers in the EAA beginning with farms in the S-5A sub-basin and extending westward to the other sub-basins in the EAA.

Task 2: Conduct BMP Training Workshops: This task includes tailored BMPs training seminars and workshops for growers groups. In this year a version in Spanish has been incorporated to better train the Spanish speaking work force of the EAA. This year, we also started on-farm BMP training sessions.

Objective: Provide concise and updated BMP implementation information via training seminars to the EAA grower community. The information provided should explain in layman's term the rationale and techniques of individual BMPs and the more recent research results on other water quality issues.

Task 3: Development of BMP Extension Materials: This task includes the development and publication of extension material on BMP implementation in the EAA.

Objective: Provide extension material on the most commonly used BMPs in the EAA to the grower community. This year, Spanish versions of extension materials for some commonly used BMPs have been developed to better serve the Spanish speaking community.

TASK I: FARM BMP CONSULTATION PROGRAM

INTRODUCTION

The sustained success of the BMP program in the EAA depends on the persisting efforts of everybody involved, i.e. farm water quality personnel, farm managers, drainage pump operators, fertilizer applicators, land owners, UF/IFAS personnel, and SFWMD personnel. However, the success that the BMP program has achieved since the implementation of the program may be influenced by the constant changes that this area is currently experimenting and those expected for the future. Some of the changes in the EAA that may impact high P load reductions that the BMP program has so far achieved in the EAA includes: Increase P levels in the waters of Lake Okeechobee that is used for irrigation on EAA farms, the slow decline in the acreage planted to sugarcane and the associated increase in the acreage to less water tolerant and/or higher P demanding crops, and the potential negative impact of soil subsidence on farm drainage volumes and drainage water quality in the basin. Thus, under these uncertainties that the EAA basin is facing, the importance of proper and uniform BMP implementation across the entire basin becomes more necessary to ensure the continued success of the BMP program in the Glades area.

METHODOLOGY

The one-on-one consultation program starts with an initial contact with the farm manager. After the initial contact the BMP program is explained in detail and an initial appointment to visit the farm is set up. A more detailed outline of the steps involved in the Farm BMP Consultation Visits is shown below:

- 1) Initial farm basin selection and contact
 - a) Contact via phone or intermediary
 - b) Explain IFAS farm consultation program
 - c) Setup initial appraisal appointment
- 2) BMP permit data collection and review
 - a) Review and summarize farm basin, concentration, and load history
 - b) Review and summarize SFWMD permit and related documentation

- 3) Appraisal and consultation with grower
 - a) Visit farm and observe farm operation with farm personnel
 - b) Discuss with grower implementation of farm BMPs
 - c) Review farm P load history and SFWMD BMP reviews with grower
 - d) Provide written implementation guides to growers
 - e) Explain specific recommendations, if any
 - f) Obtain feedback on recommendation from grower

The UF/IFAS researchers utilize and refer to a BMP appraisal checklist to ensure that most of the factors that affect BMP performance are evaluated and investigated during the farm BMP consultation visits and discussions with the growers. A copy of the BMP appraisal checklist is included in **Appendix A**. The BMP appraisal checklist is comprised of six main topics: BMP implementation methods, farm physical layout, farming operations, farm drainage volume and flow, farm drainage water P concentration, and farm characteristics and management. Each of the main topics is discussed informally with farm personnel to provide researchers with a general understanding of farm operations and management. Selected topics are discussed in detail if the related farming practices are not clearly understood by researchers and/or they are perceived by researchers to potentially have a negative effect on BMP performance.

This year we started to offer on-farm BMP training to growers during the farm consultation visits. If a BMP training is requested, a time, date and numbers of participants are given by the grower. The training presentations are a condensed versions of the general BMP trainings presented at the EREC auditorium every year, or specific topics of interest to the grower. This year we have also translated all BMP presentations into Spanish to better serve the Spanish speaking personnel from the different farms in the EAA. A copy of BMP presentations translated into Spanish is included in Appendix B. EDIS publications addressing the more commonly used BMPs in the EAA have also been translated into Spanish, and are generally distributed to all participants during the on-farm BMP presentations in Spanish. A copy of the EDIS publications translated into Spanish is presented in Appendix C.

After the on-farm BMP presentation and following discussion, a follow-up farm visit is generally scheduled for a later date. During the farm visit, the manager or other farm personnel is accompanied by IFAS staff to the different properties of the farm. The group

visits the main water control structures and drainage water sampling installations of the farm. Other points of interest are the farm's canal configuration and management of cropped and fallow fields. During the site visit farm personnel have the opportunity to ask IFAS staff regarding any issues or problems with BMP implementation and to educate and receive feedback from IFAS staff concerning any farmer-established, alternative BMP practices or modifications to BMPs. Other points discussed during the farm visit include concerns that the farmer may have about the BMP program or other topics that may affect the water quality program in their farms. At this time, IFAS personnel engage in informal discussion of potential research topics that may be of interest to the farmer to further improve the water quality of the farm and other topics that are important for the farmer community of the EAA.

In this annual report we are also including evaluation results from some BMP training workshops offered at the EREC during 2006. A copy of the BMP training evaluation form given to all participants is included in Appendix A. In addition, preliminary results of a new survey that will be given to all farm managers and other farm personnel involved in the farm's BMP program during the on-farm BMP trainings and follow-up farm visits are also included in this report. The objective of this survey is to get an input of the overall BMP program in the EAA from the grower's perspective. A copy of the cover letter and BMP survey given to farm managers is included in Appendix A. The BMP survey is comprised of three main parts: comments about BMP trainings offered at the EREC auditorium, comments on Farm BMP Consultation Program, and comments of the overall BMP program in the EAA and research needed to improve BMP performance at the farm level in the EAA.

RESULTS

The farm BMP consultation program continues to be well accepted by the grower community of the EAA. Farm managers and other farm personnel involved in the BMP program continue to be very cooperative with IFAS personnel during the farm visits. During the second year of the farm BMP consultation program the efforts have been concentrated on farms in the S-6 sub-basin. However, some remaining farms from the S-5A and some farms from the S-7 sub-basins were also visited during this period (Figure 1). Table 1 lists the farms ID and associated acres in the S-6 sub-basin. At this time, 30% of the total acreage (35,761 acres) has been completed, with the remaining farms to be completed in the second half of this year. In addition, 13% of the total acreage (15,717 acres) of the remaining farms

from the S-5A sub-basin (Table 2) and 6% of the total acreage (7,294 acres) from the S-7 sub-basin were also completed during this period.

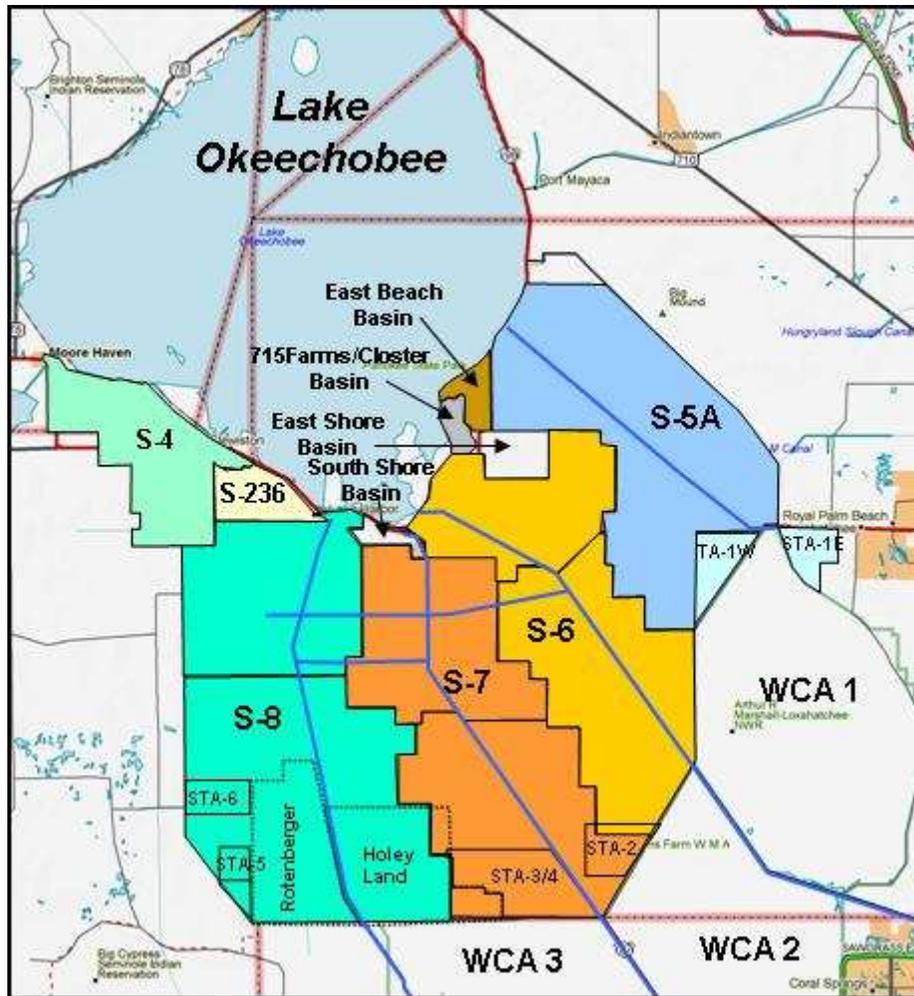


Figure 1. The EAA basin with boundaries of the sub-basins. For this report the EAA sub-basins are grouped in to four sub-basins: S-5A sub-basin, S-6 sub-basin (S-6 and the NE portion of S-2 sub-basin), S-7 sub-basin (S-7 and SW portion of S-2 sub-basin), and S-8 sub-basin (S-8 and S-3 sub-basins).

Table 1. Total acreage of farms located in the S-6 sub-basin.

Basin ID	2006 Acres	Basin ID	2006 Acres
50-003-03*	118	50-035-01	478
50-006-02	359	50-039-01	63
50-006-03	640	50-045-01	282
50-007-01*	6473	50-047-01	630
50-009-04	317	50-047-02	640
50-010-01*	784	50-047-03	1832
50-010-02	5327	50-047-04	198
50-010-04	7159	50-047-05	314
50-011-01*	1748	50-047-08	1558
50-011-03*	14338	50-048-01*	1185
50-011-04*	4066	50-051-01	811
50-012-01	1022	50-053-01	149
50-018-10	8254	50-055-01	393
50-018-11	1871	50-055-02	810
50-020-01	320	50-055-03	2871
50-021-01	2558	50-056-01	850
50-023-01	278	50-060-01	8137
50-027-01	2772	50-060-02*	7614
50-027-02	799	50-061-01	639
50-027-03	1353	50-061-18	1555
50-027-04	2520	50-061-20	156
50-028-01*	220	50-062-10	8772
50-030-01	446	50-065-02	938
50-031-01	1609	50-065-07	513
50-031-02	1387	50-065-10	792
50-031-03	602	50-070-01	245
50-034-01	7897	50-070-02	244
50-034-02	601		
Completed Acres*		35,761	30%
Remaining Acres		82,747	70%
Total Acres		118,508	100%

Table 2. Total acreage of farms located in the S-5A sub-basin.

Basin ID	2005 Acres	Basin ID	2005 Acres
50-002-01*	5656	50-047-07	3494
50-002-02	9285	50-049-01	1909
50-004-01*	909	50-054-01	7600
50-006-01*	397	50-054-02	960
50-007-02	5717	50-054-03	1227
50-013-01	1363	50-054-04	3684
50-015-01*	3276	50-059-01	9614
50-015-02*	2554	50-059-02	1768
50-016-01	1497	50-059-03	710
50-018-01	5902	50-059-04	306
50-018-02	6594	50-061-08	375
50-018-03	9062	50-061-15	6760
50-018-12	1655	50-061-17	1598
50-018-13	594	50-064-01	899
50-025-01*	824	50-064-03	145
50-033-02*	1159	50-064-04	1150
50-035-02*	1634	50-065-03	3752
50-035-03*	205	50-065-05	930
50-037-01*	1663	50-065-06	454
50-038-01	1285	50-065-08	628
50-040-01*	216	50-068-01	2616
50-040-02*	499	50-068-02	1998
50-044-01	2169	50-073-01*	68
Completed Acres		98,414	84%
Remaining Acres*		18,347	16%
Total Acres		116,761	100%

On-farm BMP Training

The format of the farm BMP consultation program was improved this year, with the addition of the on-farm BMP training and the introduction of a BMP survey that will be fully implemented during the second half of this year. These changes have resulted in a better interaction between IFAS personnel and farm managers and other personnel involved in the farm's BMP program. The on-farm BMP training presentations are shorter versions on the regular BMP training presentations offered at the EREC every year. The advantage of this on-farm training presentations are the exclusive attention that the speaker gives to a smaller audience and the emphasis on special topics that are of most interest to that particular farm.

Key issues requested for discussion during the on-farm presentations varied from farm to farm. One farmer requested a BMP training presentation with more emphasis on sediment control BMPs and field documentation. Another farm was more interested in sediment control BMPs, pump log documentation, and rainfall detention. Other topics of interest were soil testing and fertilizer recommendations for specialty crops, canal cleaning frequency, and effective control practices for surface aquatic vegetation. They may also request advice on how to address BMP Verification and Assessment letter received from SFWMD. Something worth noting during these presentations is the interaction of the audience. It appears that smaller groups stimulate more active participation between the growers and IFAS personnel during the presentation.

The on-farm training presentations have also been expanded to trainings in Spanish to better serve the Spanish speaking force of the different farms in the EAA. During one on-farm BMP trainings, a farmer requested the training be given in Spanish to accommodate the majority of the participants. This was our largest on-farm BMP training session with 32 participants. The participants were very interactive and asked questions throughout the presentation. At the beginning of the presentation IFAS personnel distributed handouts of the most commonly used BMPs in the EAA basin. However, most of our written material and presentations are in English and as a result of this experience with this farm, all EDIS publication as well as BMP presentations have been translated into Spanish to better serve those farms with a large Spanish speaking work force.

BMP Consultation Program

Generally during farm visits, short discussions are first conducted about the objectives of the BMP Consultation Program with the farm managers at the main offices of the farms. At this time, copies of the BMP Consultation Survey are now handed out to the managers and personnel that had previously attended the on-farm BMP presentations. Afterward, either the farm manager or assistant farm manager accompany IFAS personnel to the different properties of the farm. The topics discussed during these visits ranged from main crops grown on the farm to the different BMPs that are being implemented throughout the farm. The farms visited were either sugarcane farms or mixed crop farms with sugarcane, sod, sweet corn, green beans, and rice. Some of these farms have properties at different locations throughout the S-6 and S-7 sub-basins, however, they try to implement the same suite of BMPs at all locations. Some of the BMPs discussed during the farm visits included water detention, improved infrastructure, soil testing, fertilizer application control and sediment control BMPs. Most of the main farm canals were clean with little aquatic vegetation; however, water lettuce is a problem at some pump-houses. Spot spraying (Rodeo or 2, 4 D depending on the weed) is frequently used to control small infestations and keep the aquatic vegetation growth at minimum. However, sometimes weed control in some farm canals is a challenge because of the presence of vegetables in neighboring farms. A regular canal cleaning program is one of the most commonly used sediment control BMP in the EAA basin. The farm managers explained that all main farm canals are cleaned once a year (Figure 2). However, some years the equipment used to clean canals is not available and only canal reaches upstream of the pump-houses are cleaned. To avoid being out of compliance, some farmers implement one or two extra sediment control BMPs that can be claimed in those years when one of their regular BMPs is not implemented for any reason.

Some farmers are being creative in the implementation of some sediment control BMPs. An assistant farm manager from one of the visited farms showed us some sod fields that have been replaced with sugarcane. During land preparation, a strip of sod is left around field ditches and canal banks to stabilize the soil and control sediment runoff into canals. All sod and sugarcane fields are laser leveled before planting, facilitating a more uniform drainage and irrigation across the fields. All these farms are making also a big effort to improve their infrastructure. Some of the improvements observed during the farm visits were the installation of new culverts and widening of some farm canals, which will allow the farmer a more effective water management throughout the farm. Another BMP discussed during the

farm visits was collection of soil samples and soil analysis. Soil samples are collected for every field that is planted with any crop. Depending on the farmer, soil samples are sent to the EREC Soil Testing Laboratory or a private laboratory. Farmers are being careful to maintain good records of all soil analysis and fertilizer application in their farms. They make sure that either farm personnel or outside contractors keep good documentation of all farm activities. Farmers have accumulated a good data base on the fertility status of most of their fields, which allows them to make adjustment on their fertilizer management throughout the crop growing season.



Figure 2. Regular canal cleaning on one farm from the S-6 sub-basin.

Flooding is a common cultural practice in the EAA (Figure 3). Growers flood fallow fields for a number of reasons, among which are disease and insect control, nematode control, improvement of soil tilth and reduction of soil loss from biological oxidation. Some of the farms visited had some of their field flooded, however, the acreage flooded during this year have decreased due to low water levels in Lake Okeechobee. Use of rice as a cover crop is also a common BMP practice in the EAA that in addition of the rice production provides protection to fallow fields reducing soil losses due to wind and water erosion. Rice is the only crop for which flooding is maintained during the crop production period, reducing soil losses due to microbial oxidation.



Figure 3. Flooding of fallow fields on one farm from the S-6 sub-basin.



Figure 4. A cover crop of rice reduces soil erosion and soil subsidence.

BMP Consultation Program Survey

The BMP consultation survey is in its first stages and will be fully implemented in future on-farm BMP trainings and farm visits. Table 3 has preliminary results from this survey that was collected from three farm managers during some of the farm visits in the S-6 sub-basin. Although there is not enough information to analyze at this time, these preliminary results give us an indication of how farmers evaluate the role of IFAS personnel on the BMP consultation program and the efforts toward the BMP program in the EAA. The growers also indicate future research topics to improve the overall quality of drainage water leaving EAA farms. These early results show that in general, farmers are satisfied with the format and information given in the BMP training workshops at the EREC. They also believe that the role of IFAS personnel to the BMP program in the EAA is very important.

Preliminary results evaluating the BMP consultation program are positive and indicate that farmers believe that on-farm BMP training and discussions during follow-up farm visits are important and can make a difference in their BMP program. This information also allow us to asses which part of the BMP consultation program was more beneficial to the growers and which practices will benefit the most with this program. The BMP consultation program is also a great opportunity to discuss and learn what type of future research farmers believe is important to maintain the level of success the BMP program has enjoyed since its inception and to further decrease P loads of drainage water leaving EAA farms. A more complete analysis and evaluation of this survey will be presented in the next annual report.

Table 3. Preliminary results from the BMP consultation survey given to farm managers from the EAA.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The farm visit helped in the implementation of BMPs.	1 (33%)	1 (33%)	1 (33%)	-	-
Help to better understand the effect of sediments.	-	3 (100)	-	-	-
Information provided was easy to understand.	1 (33%)	2 (67%)	-	-	-
Information provided was accurate and up-to-date.	-	3 (100%)	-	-	-
Information provided was useful.	-	3 (100%)	-	-	-
All questions were adequately answered.	1 (33%)	2 (67%)	-	-	-
Increased the awareness of field documentation.	1 (33%)	2 (67%)	-	-	-
This program should be done more often.	-	1 (33%)	2 (67%)	-	-
	Two or more Times a Year	Once a Year	Once every Two Years	Never	
How often do you attend BMP training at EREC?	-	3 (100%)	-	-	
	Always Beneficial	Beneficial	Neutral	Sometime Beneficial	Never Beneficial
How beneficial is information from BMP training offered at the EREC.	2 (67%)	1 (33%)	-	-	-
	Very Supportive	Supportive	Undecided	Some what Supportive	Not Very Supportive
What is the level of support of EREC personnel on BMP program in the EAA?	3 (100%)	-	-	-	-
	On-farm Presentation	BMP Discussion	Farm Field Visit	All Parts of program	Other
What part of BMP consultation was most useful?	-	-	-	3 (100%)	-
	Water Management	Fertilizer Application BMPs	Sediment Control	Other	
Practices you are likely to change as a result of the BMP consultation program?	1 (33%)	1 (33%)	1 (33%)	-	
	Excellent	Very Good	Good	Average	Poor
How do you rate the quality and usefulness of BMP consultation program?	1 (33%)	2 (67%)	-	-	-
	Irrigation Water Quality	Abstain			
Research needed to improve BMP performance at the farm level	1 (33%)	2 (67%)			

Note: Preliminary results are based on responses from three farm managers.

Summary of BMP Consultation Program Recommendations

The most common suggestions for farmers in the S-6 sub-basin are similar to those given to farmers from the S-5A sub-basin.

Canal cleaning – Sediments and any other organic material in farm canals are a major part of the total P load leaving the EAA basin, therefore, any cultural practice that can regularly decrease the total amounts of sediments accumulated in drainage canals and field ditches will have a considerably impact on total P loads leaving the farm (Diaz et al., 2005). Canal cleaning is recommended to be implemented during quiescent farm periods and if possible in combination with irrigation to relocate re-suspended sediments to the back of the farm. Economics or lack of equipment prevents some farms to regularly clean the entire hydraulic system of the farm. Thus, it is recommended to concentrate the efforts and clean regularly the canal sections directly upstream of main drainage pumps. In addition it is recommended to avoid any drainage pumping activity during or immediately after cleaning operations to prevent the release of drainage water with high sediment concentration. A regular canal cleaning program is an important sediment control BMP that in addition of reducing the amount of sediments that can be transported out of the farm; also improve the storage and hydraulic capacity of the farm canals.

Floating aquatic vegetation control – In-stream biological growth in main farm canals is one of the major contributors of particulate P in drainage waters leaving EAA farms (Daroub et al., 2002a). Thus, limiting the growth of floating aquatic vegetation in main canals, especially upstream of major drainage structures is an important sediment control practice that is always recommended to all farm managers. An aggressive aquatic weed control is the most effective approach to reduce the main source of high P content particulate material. It is recommended to use weed-retention booms and trash racks well upstream of main drainage structures to reduce the likelihood of exporting particulate matter off the farm during drainage events. Use of herbicides to control heavy infestations is not recommended, because dead plant tissue becomes an easily transported floc material source high in P content. Mechanical harvesting of floating aquatic vegetation is recommended if economically feasible. However, herbicide spraying is sometimes the only option to achieve a broad control in heavily infested areas. Subsequent use of chemical compounds should be limited to spot spraying to keep the aquatic vegetation population to a minimum.

Velocity control – Velocity is the key control parameter for reducing particulate P export. The various types of sediments accumulated in drainage farm canals respond different to changes in hydraulic conditions (Daroub et al, 2002b). At low velocity, only the light, flocculent easily transportable sediment material will be re-suspended and transported. As velocity in the canal increases, turbulence levels increases and the forces responsible to dislodge sediment material from the canal bottom increase, resulting in larger amounts of sediment material transported off the farm. In general, the light sediment material transported at the beginning of a drainage event is the freshest biological deposited material with the highest P content, while the heaviest sediment transported at higher velocities is the oldest most mineralized sediment material. Thus, controlling canal velocities during drainage events is an important practice to reduce the amount of sediment material exported off the farm. However, recommended velocities are relative, in that they must be within the operating framework of the configuration and size of the farm canals.

Two recommendations that are often suggested to reduce water velocity are: First, to maintain a minimum canal level during drainage events that is farm specific. Canals should not be pumped to a level less than recommended or specific in the BMP permit. Low canal levels may lead to high drainage velocity in the canal that will result in sediment erosion and subsequent transport with drainage water off the farm. The second recommendation is to pump at a lower rate for longer periods of time, rather than pumping faster for shorter periods of time to drain a given volume of water. This can be accomplished by shifting to a lower capacity pump or reducing RPMs on the larger capacity pumps.

Proper BMP documentation – Most of the farmers visited in the S-6 sub-basin keep a detailed documentation of their BMP practices. However, this is an important topic that we keep reminding all growers. Proper documentation of all BMPs being implemented in the farm is a requirement by the SFWMD. District personnel conduct routine BMP verification visits to make sure that the BMPs listed in the farm's BMP permit are being properly implemented.

Recommendations were provided for proper BMP documentation on topics such as soil testing, fertilizer spill prevention, and aquatic weed control. However, the topics of more interest to the farmers were proper documentation on pump log operations, rainfall detention, and some of the sediment control BMPs. It was emphasized the importance of documenting every drainage event and the reasons for pumping. Examples were provided

explaining type of documentation needed to justify pumping events that have occurred before the rainfall detention for the farm has been achieved.

Rainfall detention is a topic that some farmers need more information for better implementation and proper documentation in the farm. Additional explanation on the topic was provided to several farmers that requested more information and guidance on proper documentation. However, this is a topic that needs more information that could be distributed to farmers to better explain this BMP practice and be used as a guide to growers for better implementation and proper documentation in the farm.

Sometimes there is a concern from the SFWMD that some of the sediment control-BMPs are not being properly implemented every year. Some farmers are proactive and are already implementing alternate sediment control practices that can be used in years that one of their regular BMPs is not implemented for any reason. This practice was explained and recommended to other farmers in the S-6 sub-basin. Additional information on some alternate sediment control BMPs that could be easily implemented in the farms was provided to some farmers.

Growers' Concerns

Quality of irrigation water from Lake Okeechobee – This is a concern that is being raised by the majority of the farmers, especially now with the drought and the low water levels in Lake Okeechobee. Data from the last five years (WY2002-WY2006) shows that the average total P load to the lake is 714 metric tons per year. This P load is over five times higher than the established TMDL of 140 metric tons, considered to be necessary to achieve the in-lake target P concentration of 40 ppb (Zhang et al., 2007). Total P loading to Lake Okeechobee for WY2006 was considerable high (795 metric ton), with an average total P concentration of 214 ppb. Growers are concerned that the deterioration in the quality of irrigation water coming from Lake Okeechobee during the last few years will have a negative impact on their BMP efforts to reduce farm P loads leaving their farms.

Cleaning and maintenance of secondary District canals – Some farmers have concerns that the quality of irrigation water is being compromised by the amount of sediment and lack of maintenance of some secondary canals. Some farmers from the S-6 sub-basin that have properties bordering the Bolles Canal in the S-7 sub-basin are very concerned about the lack of maintenance of this canal and the negative impact that irrigation water from this

canal may be having on total P loads being imported into the farms. Large sections of this canal are completely infested with aquatic vegetation and full of organic sediments, which also reduces the capacity of this canal to transport water more efficiently (Figure 5).



Figure 5. Floating aquatic weeds in the Bolles Canal.

CONCLUSIONS

The second year of the Farm BMP Consultation Program was also positively accepted by the growers of the S-6 sub-basin. All growers have been very cooperative and graciously have taken time from their busy schedule to talk with IFAS personnel to discuss their BMP program and other issues related to water quality in the area. In general, the following can be concluded:

- a) All farmers visited acknowledged the significance of the BMP Program in the EAA and are committed to continue doing everything possible to make certain that the success of the program is maintained in the entire basin.
- b) Farmers are becoming more open and are getting more comfortable discussing their farm BMP program with IFAS personnel. This level of trust is facilitating the implementation of the BMP Consultation Program, allowing an open channel of communication to give them suggestions to improve their BMP program and at the same time get an honest feedback of usefulness of the program. This level of trust and communication will be a valuable tool to evaluate the overall BMP program through the implementation of the BMP survey in future farm visits.
- c) The introduction of the on-farm BMP training workshops during this past year has been well-received by the growers. The level of interaction between participants and IFAS personnel during trainings was higher than expected. The translation to Spanish of all BMP training material and subsequent trainings in Spanish have also been well received by the farming community of the EAA, especially those farms with a large Spanish speaking force.
- d) Farmers are aware of the vital role that research has played in the BMP program in this area. Some farmers even have suggestions regarding topics they would like to be researched in the near future. They understand that more research is still needed on BMP and other water quality issues to maintain the success of this program and are willing to contribute and collaborate any way they can with IFAS personnel on future projects.

In summary, it can be concluded that the second year has been a success in terms of farmer's participation and willingness to listen and make changes to their BMP practices to further improve the water quality of drainage waters leaving their farms. The positive attitude observed during the on-farm BMP training workshops and the overall cooperation from farm

managers during follow-up farm visits is a positive sign of the level of commitment that EAA farmers have toward the BMP program in the Glades area. They are committed to continue doing their best to improve their farm BMP program and make sure that the basin continues to be successful in reducing the total P loads leaving EAA farms.

TASK II: BMP TRAINING WORKSHOPS

Best Management Practices workshops have been designed by UF/IFAS faculty to cover all major topics of the BMP program to insure uniform and successful implementation by EAA growers. The topics covered includes a review of Rule 40E-63, BMPs for Atrazine and Ametryn, BMP table overview, soil testing and plant tissue analysis, fertilizer application BMPs, rainfall detention, sediment control, and particulate P research. A copy of BMP all presentations translated to Spanish are included in **Appendix B**.

From the period of July 1st, 2006 to June 30th, 2007, a total of seven BMP training workshops were conducted. Three BMP workshops were conducted in the Conference Center of the EREC. The other four were on-farm BMP training seminar for specific companies. The workshops generally last around 3½ to 4 hours where all aspects of the SFWMD BMP table are covered. In addition, latest research findings different environmental topics are shared with all participants. The presentations are given by S.H. Daroub, T.A. Lang, and O.A. Diaz. Important information covering the proper use of the pesticide Ametryn and Atrazine are also presented by Dr. Curtis Rainbolt, weed scientist at the EREC. Other faculty members with different expertise on the different BMP topics of interest to the growers that have participated on these workshops include Dr. Mabry McCray, Agronomist, Dr. Alan Wright, Soil Scientist, and Dr. Cody Gray, Aquatic Weed scientist. The on-farm BMP training seminars are new and are generally tailored for each farm. On-farm training seminars are shorter than typical BMP workshops lasting approximately two hours. These training seminars are given by T.A. Lang and O.A. Diaz. Continuing education units (pesticide and certified crop advisor) are offered to all participants. Material covered as well as list of attendees from each workshop has been already sent to the SFWMD.

Following is the list of all workshops conducted from July 1, 2006 to June 30, 2007:

1. Two BMP workshops were conducted for **U.S. Sugar Corporation** on September 20 and September 28, 2006 with 21 participants.

2. One open BMP workshop was conducted on October 12, 2006. This workshop was open to everyone who missed earlier workshops. A total of 43 participants attended this workshop. Some personnel from the 298 districts were in attendance at this workshop.
3. One on-farm BMP training workshop was conducted for **Star Ranch Corporation/Star Ranch Enterprises Inc.** on November 8, 2006 with 8 participants.
4. One on-farm BMP training workshop was conducted for **East Beach Water Control District** on December 8, 2006 with 9 participants.
5. One on-farm BMP training workshop was conducted for **Hundley Farms** on December 18, 2006 with 4 participants.
6. One on-farm BMP training seminar was conducted for **TKM Farms** on January 10, 2007. This BMP training was given in Spanish to a total of 32 participants.

BMP Training Evaluations

Results from four BMP training Workshops given in 2006 are presented in this annual report (Figure 6 and Tables 4 to 7). Results from the BMP training are divided in three parts: i) speakers performance and material presented rating, ii) reason for attending and suggestion for improvement, and iii) most and least beneficial topics and new topics for future training.

Results from the first part show that more than 90% (excellent and good) of the participants considered that the BMP training workshop met their objectives. Similarly, about 90% of the participants considered that the speakers were effective in explaining the different BMP topics, and the material presented was appropriate for the trainings. Results from the second and third parts were more diverse depending on the different groups being evaluated. The majority of the participants (67% to 73%) attended the BMP training to learn in general more about BMPs to reduce P loads from the farms. Other reasons were to learn more about BMP rules (6%) to be in compliance, pumping practices (6 to 11%), earning both pesticides CEUs and Certified Crop Advisor CEUs (11%), and learn more about BMPs for pesticides use in the EAA (3%). The majority (78 to 94%) of the participants was also satisfied with the material and format of the BMP training presentations, and was also confident in recommending these BMP training to others (88 to 100%).

Results from the third part shows that the majority of the participants (45 to 70%) considered all topics presented to be very important and beneficial to the overall BMP program. However, 6 to 22% of the participants considered that fertilizer application BMPs was the most beneficial topic of the training workshop. Other important topics considered were sediment control and particulate P BMPs (18 to 25%), water detention BMPs (6 to 22%), aquatic weeds control and pesticide use BMPs (11 to 22%), and soil testing (9%). In contrast, the majority of the audience (78 to 100%) considered that none of the BMP topics presented could be labeled as the least beneficial part of the BMP training. However, 3 to 11% considered that rainfall detention was the least beneficial topic of the training. Other topics considered were aquatic weed control (11%), soil testing and plant tissue analysis (6%), and fertilizer application BMPs (6%). The majority of the participants (88% to 100%) do not want to see any new topics in future BMP training workshops. Nevertheless, 3 to 6% would like more detail explanation of the BMP point system. Other topics of interest for future BMP training workshop include water table research (6%), and information on sulfur in the EAA (3%).



Figure 6. A BMP training workshop offered to EAA growers at the EREC.

Table 4. Survey results from a BMP training workshop of Sugar Farms Cooperative; May 23, 2006.

	Excellent	Good	Average	Poor	Abstain
The BMP workshop met your objectives.	7 (41%)	9 (53%)	1 (6%)	-	-
The speakers were effective during the training.	6 (35%)	11 (65%)	-	-	-
Rating of the training material.	10 (59%)	6 (35%)	1 (6%)	-	-
Reason for attending training.	Learn more P BMPs 12 (71%)	Learn rules to be in compliance 1 (6%)	Learn more Pumping BMPs 1 (6%)		Abstain 3 (18%)
Suggestion for improvement.	None 16 (94%)	Add New Topics 1 (6%)	Shorten Training -		Abstain -
Would you recommend this training to others?	Yes 16 (94%)	No -			Abstain 1 (6%)
Most beneficial topic of training.	Fertilizer Application BMPs 1 (6%)	Sediment Control and PP 3 (18%)	Water Detention BMPs 1 (6%)	All Topics 12 (70%)	Abstain -
Least beneficial part of training.	Rainfall Detention -	Aquatic weeds Control -	Soil Testing and Plant Tissue -	None 17(100%)	Abstain -
New topics that you would like in the future.	Explain More Point system 1 (6%)	Information on Sulfur -	Water Table Research 1 (6%)	None 15 (88%)	Abstain -

Note: Total attendance = 18, Participants in the evaluation = 17.

Table 5. Survey results from a BMP training workshop of Okeelanta Corporation; May 25, 2006.

	Excellent	Good	Average	Fair	Abstain
The BMP workshop met your objectives.	11 (73%)	3 (20%)	1 (7%)	-	-
The speakers were effective during the training.	11 (73%)	3 (20%)	1 (7%)	-	-
Rating of the training material.	12 (80%)	2 (13%)	-	1 (7%)	-
	Learn more P BMPs	Learn rules to be in compliance	Learn more Pumping BMPs		Abstain
Reason for attending training.	11 (73%)	-	-		4 (27%)
	None	Add New Topics	Shorten Training		Abstain
Suggestion for improvement.	13 (87%)	1 (7%)	1 (7%)		-
	Yes	No			Abstain
Would you recommend this training to others?	15 (100%)	-			-
	Fertilizer Application BMPs	Sediment Control and PP	Water Detention BMPs	All Topics	Abstain
Most beneficial topic of training.	2 (13%)	3 (20%)	1 (7%)	9 (60%)	-
	Rainfall Detention	Aquatic weeds Control	Soil Testing and Plant Tissue	None	Abstain
Least beneficial part of training.	-	-	-	15(100%)	-
	Explain More Point system	Information on Sulfur	Water Table Research	None	Abstain
New topics that you would like in the future.	-	-	-	15(100%)	-

Note: Total attendance = 20, Participants in the evaluation = 15.

Table 6. Survey results from a BMP training workshop for Sugar Cane Growers Cooperative; June 1, 2006.

	Excellent	Good	Average	Poor	Abstain
The BMP workshop met your objectives.	4 (44%)	5 (56%)	-	-	-
The speakers were effective during the training.	3 (33%)	6 (67%)	-	-	-
Rating of the training material.	5 (56%)	4 (44%)	-	-	-
Reason for attending training.	Learn more P BMPs 6 (67%)	Learn more P BMPs and earn CEUs 1 (11%)	Learn more Pumping BMPs 1 (11%)		Abstain 1 (11%)
Suggestion for improvement.	None 7 (78%)	More Explanation 1 (11%)	Shorten Training 1 (11%)		Abstain -
Would you recommend this training to others?	Yes 8 (89%)	No 1 (11%)			Abstain -
Most beneficial topic of training.	Fertilizer Application BMPs 2 (22%)	Sediment Control and PP 2 (22%)	Aquatic weeds and Pesticides 1 (11%)	All Topics 4 (45%)	Abstain -
Least beneficial part of training.	Rainfall Detention 1 (11%)	Aquatic weeds Control 1 (11%)	Soil Testing and Plant Tissue -	None 7 (78%)	Abstain -
New topics that you would like in the future.	Explain More Point system -	Information on Sulfur -	Other Topics -	None 9 (100%)	Abstain -

Note: Total attendance = 13, Participants in the evaluation = 9.

Table 7. Survey results from an Open BMP training workshop; October 12, 2006.

	Excellent	Good	Average	Poor	Abstain
The BMP workshop met your objectives.	13 (41%)	15 (47%)	1 (3%)	-	3 (9%)
The speakers were effective during the training.	12 (38%)	16 (50%)	-	-	4 (12%)
Rating of the training material.	13 (41%)	14 (44%)	1 (3%)	-	4 (12%)
Reason for attending training.	Learn more P BMPs 22 (69%)	Learn more P BMPs and earn CEUs 4 (12%)	Learn more Pesticide BMPs 1 (3%)		Abstain 5
Suggestion for improvement.	None 27 (84%)	Some 5 (16%)			Abstain -
Would you recommend this training to others?	Yes 28 (88%)	No -			Abstain 4 (12%)
Most beneficial topic of training.	Rainfall Detention 7 (22%)	Sediment Control and PP 8 (25%)	Aquatic weeds and Pesticides 7 (22%)	Soil Testing 3 (9%)	Abstain 7 (22%)
Least beneficial part of training.	Rainfall Detention 1 (3%)	Fertilizer Application BMPs 2 (6%)	Soil Testing and Plant Tissue 2 (6%)	None 27 (84%)	Abstain -
New topics that you would like in the future.	Explain More Point system 1 (3%)	Information on Sulfur 1 (3%)	Other Topics 1 (3%)	None 29 (91%)	Abstain -

Note: Total attendance = 43, Participants in the evaluation = 32.

TASK III. DEVELOPMENT OF BMP EXTENSION MATERIALS

Three extension publications were translated to Spanish and published online at the UF/EDIS extension web <http://edis.ifas.ufl.edu/> in 2007. A fourth publication was also translated to Spanish and submitted for publication. These publications cover four of the most commonly used BMPs in the EAA. The objective of these translations is to better inform the Spanish speaking participants, which is an important part of the working force in the different farms in the EAA. Copies of these extension materials will be made available in future BMP trainings and also during the Farm Consultation Visits. Full copies of these extension publications are included in **Appendix C**. Following is a list of the EDIS publications translated to Spanish:

1. Daroub, S.H., O.A. Diaz, T.A. Lang, V.M. Nadal, and M. Chen. 2007. Mejores Prácticas de Manejo en el Area Agrícola de los Everglades: Pruebas de Suelos. EDIS SL225/SS472 <http://edis.ifas.ufl.edu/SS472>
2. Lang, T.A., S.H. Daroub, O.A. Diaz, V.M. Nadal, and M. Chen. 2007. Mejores Prácticas de Manejo en el Area Agrícola de los Everglades: Control de la Aplicación de Fertilizantes. EDIS SL232/SS470 <http://edis.ifas.ufl.edu/SS470>
3. Diaz, O.A., S.H. Daroub, R.W. Rice, T.A. Lang, V.M. Nadal, and M. Chen. 2007. Mejores Prácticas de Manejo en el Area Agrícola de los Everglades: Prevención de el Derramamiento de Fertilizantes. EDIS SL231/SS471 <http://edis.ifas.ufl.edu/SS471>
4. Diaz, O.A., T.A. Lang, S.H. Daroub, and V.M. Nadal. 2007. Mejores Prácticas de Manejo en el Area Agrícola de los Everglades: Controlando el Fósforo en Partícula y Sedimento en Canales. (Submitted for publication).

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- Zhang, J., R.T. James, G. Ritter, and B. Sharfstein. 2007. Chapter 10. Lake Okeechobee protection program – State of the Lake and watershed. *In 2007 South Florida Environmental Report. South Florida Water Management District, West Palm Beach, FL.*

APPENDIX A. FARM BMP CONSULTATION MATERIALS

FARM BMP CONSULTATION PROGRAM CHECKLIST

BMP TRAINING WORKSHOP EVALUATION FORM

APPENDIX B. BMP WORKSHOP TRAINING MATERIALS

APPENDIX C. BMP EXTENSION PUBLICATIONS

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