

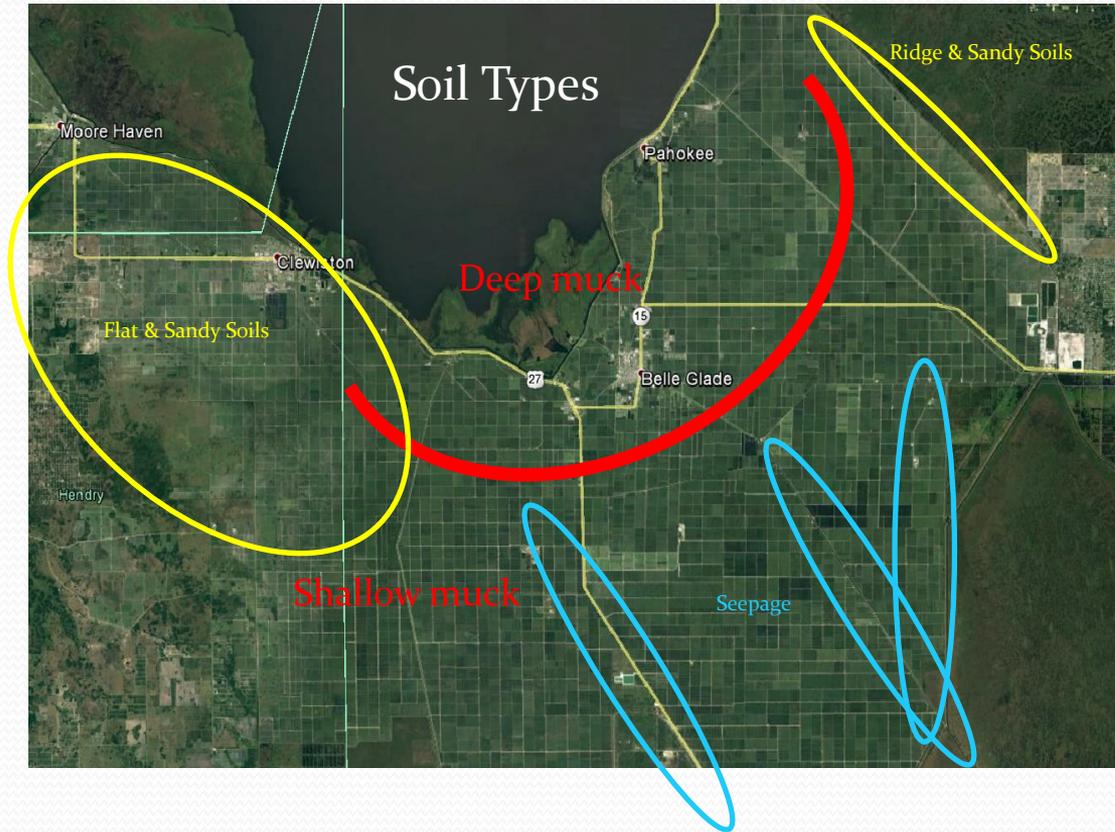
# Selection of Suitable BMPs

## Workshop

Luis M. Girado

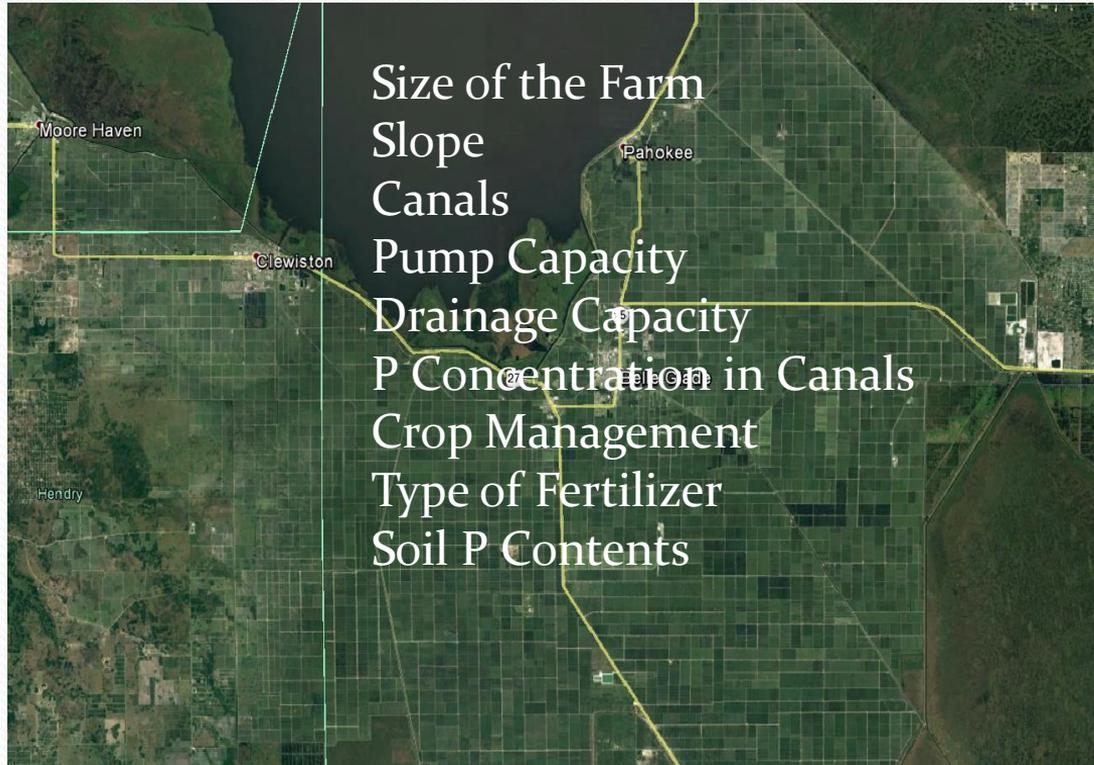
# Farm Conditions that Characterize a BMP Plan

## Are All Farms Equal?



# Farm Conditions that Characterize a BMP Plan

## Are All Farms Equal?



# Farm Conditions that Characterize a BMP Plan

General	Size of Farm	< 1,200 acres	
		1,200 - 4,000 acres	
		> 4,000 acres	
	Slope	High (2' Per_Mile)	
		Moderate (1' Per_Mile)	
Flat			
Infrastructure	Canals	Poor	
		Adequate	
		Excellent	
	Pump Capacity	> 1 inch / day	
		= 1 inch / day	
		< 1 inch / day	
Drainage	Poor		
	Adequate		
	Excellent		
P Levels	P Concentration in Canals	High	
		Medium	
		Low	

Soil Characteristics	Soil Type	Sandy	
		Sandy Muck/Mucky Sand	
		Shallow Muck	
		Deep Muck	
	Soil PH	Low	
		Medium	
		High	
	Soil Depth	Deep	
		Medium	
		Shallow	
	Base Rock	Compact	
		Fragmented	
	Seepage	Yes	
No			

# Farm Conditions that Characterize a BMP Plan

<b>Management</b>	<b>Rotation</b>	Vegetables	
		Sod	
		Corn	
		Cane	
		Rice	
		Fallow	
<b>P Levels in the Soil</b>	<b>P Fertilizer</b>	Soluble	
		Band	
		Split	
		Slow R	
	<b>Soil Test Pm3</b>	High >50	
		Medium 20 - 50	
		Low < 20	

# Effects of BMP's on the Farm

Water Management BMP's		
<i>Effect on the Farm</i>	<i>BMP Practice</i>	Rank
Minimize Discharge	Water Detention	
Minimize Sediment Transport	Start and Stop Elevations	
Fertilizer BMP's		
Apply only what is needed	Soil Tests and Calibrated Rates	
Avoid Contamination of canals	Spill Prevention	
Sediment Control BMP's		
Maximize Conveyance	Canal Improvement	
Water Control	Raisers	
	Stop Waters	
	Recirculation Pumps	
	Land Stepping and Staging	
Sediment Traps	Sumps	
	Berms	
Erosion Control	Rotation Crops	
	Land Leveling	
	Vegetation in Canal Banks	

## BMP Workshop

### Example:

- 1,000 acre farm producing a rotation of sugarcane, and vegetables in 12 inches of muck. One central wide canal dug through the rock with an irrigation pump and a 40,000 GPM drainage pump. Two canal ditches per field of 30 acres. Culverts with risers. Pockets of wet land. High fertility due to fertilizers and soil amendments.

# Farm Conditions that Characterize a BMP Plan

General	Size of Farm	< 1,200 acres	X
		1,200 - 4,000 acres	
		> 4,000 acres	
	Slope	High (2' Per_Mile)	
		Moderate (1' Per_Mile)	
		Flat	X
Infrastructure	Canals	Poor	
		Adequate	
		Excellent	X
	Pump Capacity	> 1 inch / day	
		= 1 inch / day	X
		< 1 inch / day	
Drainage	Poor		
	Adequate		
	Excellent	X	
P Levels	P Concentration in Canals	High	X
		Medium	
		Low	

Soil Characteristics	Soil Type	Sandy	
		Sandy Muck/Mucky Sand	
		Shallow Muck	
		Deep Muck	X
	Soil PH	Low	
		Medium	X
		High	X
	Soil Depth	Deep	
		Medium	X
		Shallow	
	Base Rock	Compact	
		Fragmented	X
	Seepage	Yes	X
		No	

# Farm Conditions that Characterize a BMP Plan

Management	Rotation	Vegetables	X
		Sod	
		Corn	
		Cane	X
		Rice	
		Fallow	
P Levels in the Soil	P Fertilizer	Soluble	X
		Band	X
		Split	
		Slow R	
	Soil Test Pm3	High >50	X
		Medium 20 - 50	
		Low < 20	

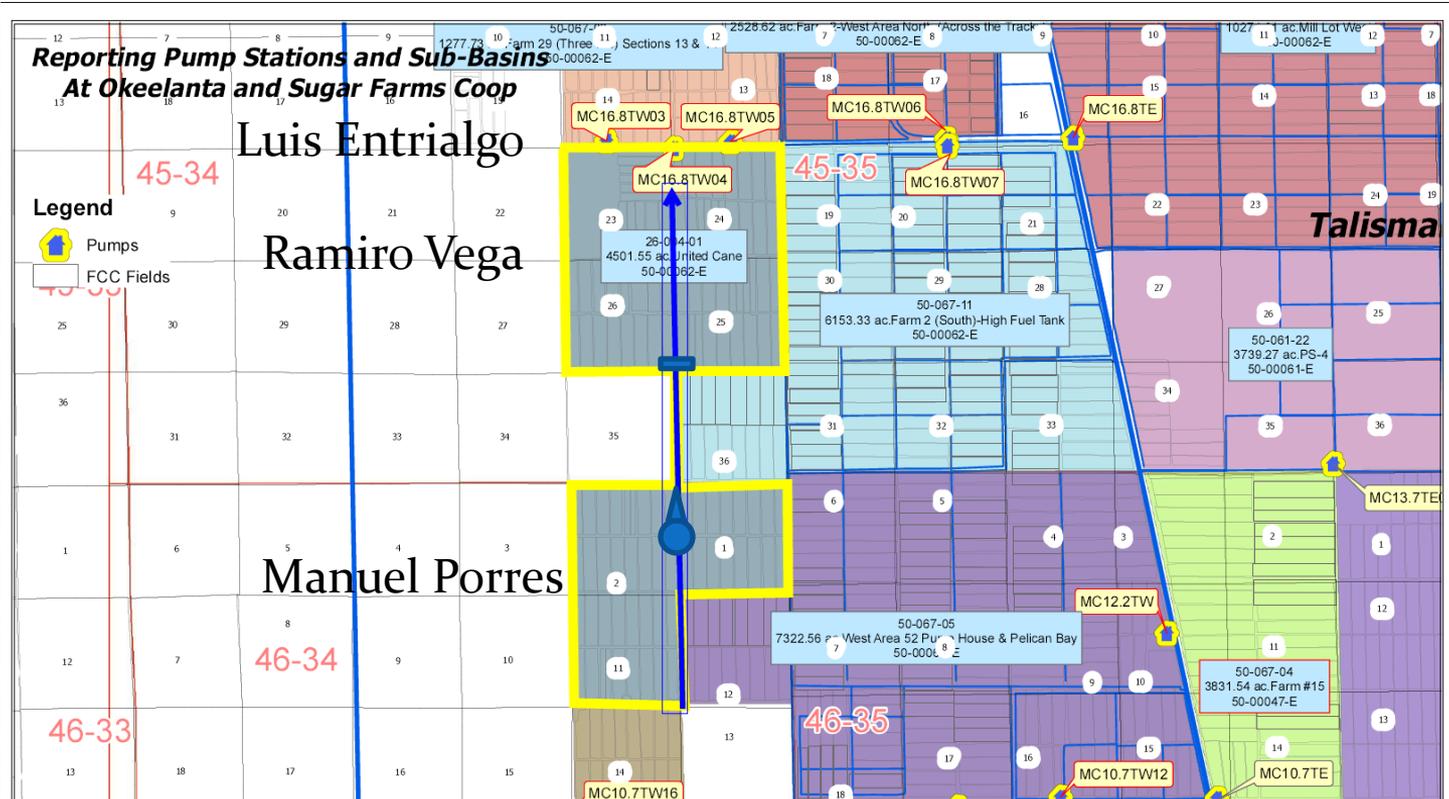
# Effects of BMP's on the Farm

Water Management BMP's		
<i>Effect on the Farm</i>	<i>BMP Practice</i>	Rank
Minimize Discharge	Water Detention	1
Minimize Sediment Transport	Start and Stop Elevations	2
Fertilizer BMP's		
Apply only what is needed	Soil Tests and Calibrated Rates	3
Avoid Contamination of canals	Spill Prevention	3
Sediment Control BMP's		
Maximize Conveyance	Canal Improvement	0
Water Control	Raisers	0
	Stop Waters	0
	Recirculation Pumps	1
	Land Stepping and Staging	0
Sediment Traps	Sumps	2
	Berms	2
Erosion Control	Rotation Crops	2
	Land Leveling	2
	Vegetation in Canal Banks	2

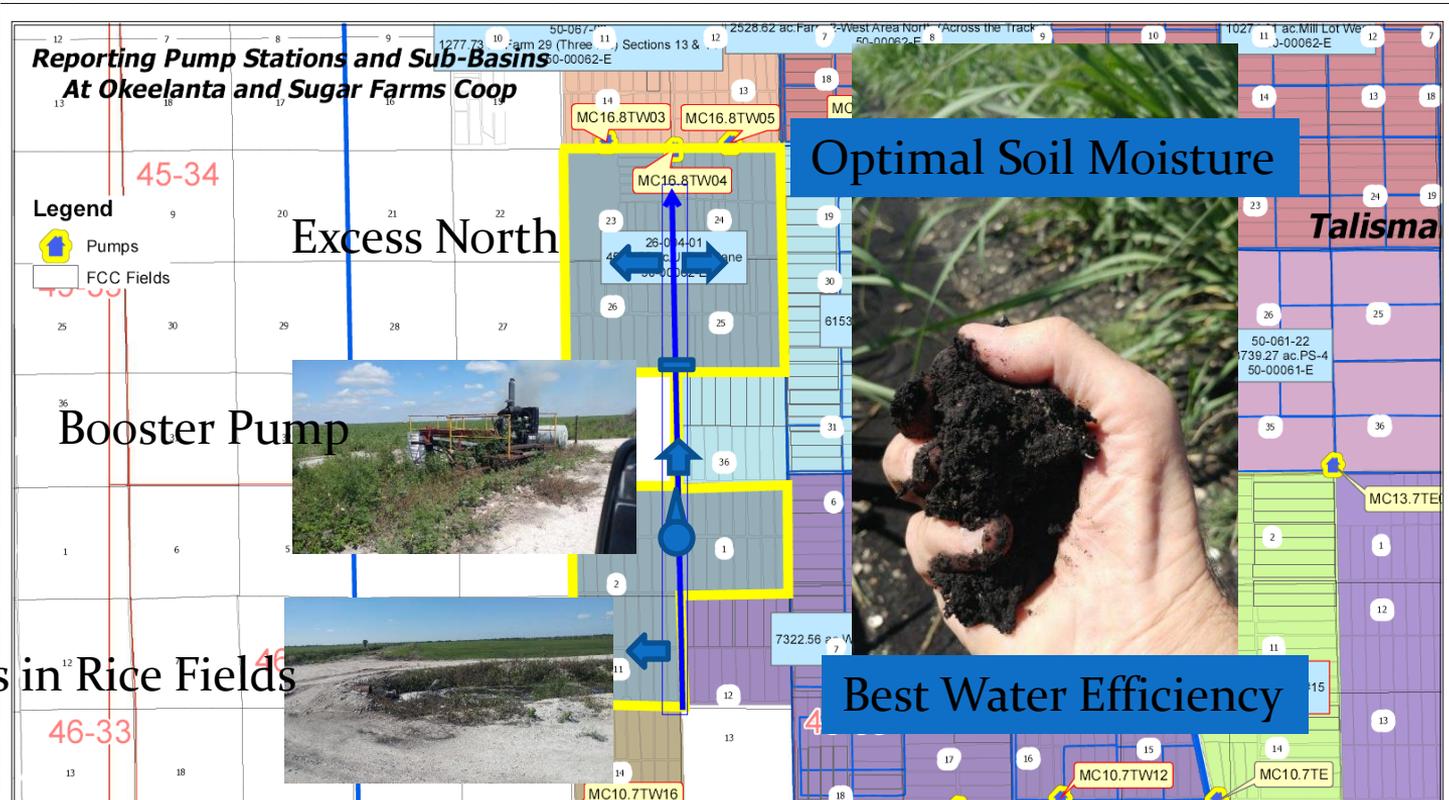
# Success Story

- 4,500 acre farm divided in two areas
- Shallow Muck and Transitional Soils
- Main crop Sugarcane and Rice
- Drainage Direction: North to South
- One main canal 5 miles long North-South with a 60,000 GPM Structure up north
- One Stop Water between the two farms
- One Buster pump at the south area
- Has Rice fields in the south end
- Received 3 inches of rain south, 1.75 inches north
- Where is it?

# Success Story Blumberg



# Success Story Blumberg



# BMP Workshop

## BREAKOUT SESSIONS

### Example Farms:

1. 640 acre shallow muck farm producing a rotation of Sugar cane and Rice. Poor drainage conditions. One central canal 2 feet deep. One drainage structure of 18,000 GPM. No irrigation.
2. 3,000 acre sandy soil farm producing a rotation of Corn and Vegetables. Good drainage conditions. 2 feet / mile slope. Several canals 6 feet deep. Two drainage structures of 40,000 GPM each. One irrigation pump and one screw gate.
3. 2,200 acre deep muck soil producing a rotation of Sugar cane, Corn and Vegetables. Good drainage conditions. One drainage structure of 60,000 GPM. 20 acre fields with two ditches each. Canals and ditches have been excavated through the rock layer. Roads run on top of the canal berm. All culverts have raisers.
4. 10,000 acre deep muck soil farm producing a rotation of Sugar cane, Rice and Corn. Medium drainage conditions. Two drainage structures of 45,000 GPM and one screw gate each. 20' X 4' canals with an average of 8 miles long.
5. 5,000 acre farm with two areas: 30% sandy soil and 70% deep muck soil. Sandy soils with 2' / mile slope. Poor drainage conditions. One drainage pump of 28,000 GPM. 15' X 4' canals. Culverts with no raisers.
6. Small farm (<2,000 acres) with excellent drainage and a flat slope. Soils are deep muck with medium pH and minimal seepage with no cap-rock. Predominantly rotating vegetables, corn, and bean crops requiring quick release P fertilizer. Expected P loads from farm are high.
7. Small farm (<2,000 acres) with excellent drainage and a high (4 ft/mile) slope. Soils are medium-to-deep sandy, sandy muck, and muck with low-medium pH. Minimal seepage with no caprock. Predominantly sugarcane and rice crops requiring regular P fertilizer. Soil P tests show high P values due to past vegetable farming. Expected P loads from farm are medium to high.

# BMP Workshop

## Example Answers:

1. A small farm with poor drainage will need to put emphasis in infrastructure to increase production. Increasing the pump capacity will help drain the farm, but digging the canals and making them wider will drain better with minimal impact on the environment. In order to preserve the environment, the canal system should have more conveyance to be able to drain better at slow water velocity. Shallow soils usually do not have a high risk of sediment transportation, therefore the priority should be on improved Infrastructure rather than sediment trapping BMP's. Cover crops are the second important BMP as a soil conservation practice. In a shallow muck area rice is very important because it prevents soil subsidence and if managed properly it can add the sediment of the irrigation water to the field, leaving a positive soil balance. Next BMP priorities are canal bank berms, vegetation in ditch banks and sediment sumps,. Leveling fields should be left out because there is not enough soil depth.
2. This is an example of a high producing vegetable farm that will typically carry high contents of P in the water. The drainage system is very efficient and operates very fast. These farms receive high fertilization rates because of the vegetables and need a strict water control to achieve high production. High fertilization rates will result in high dissolved phosphorus in the water and strict water controls will result in high particulate matter coming as sediment. Sediment transport BMP's are critical to avoid environmental damage in these farms and the Fertilizer content and application control BMP's are essential to lower the dissolved Phosphorus. Since the farm has a slope, the sediment controls are the highest priority. The farm water should be managed grouping the fields with the same level through the use of stop waters and raisers. Recirculation pumps would be beneficial to avoid discharging water and recirculating to fallow fields. Leveling fields, sumps in canal and ditches and raised culverts bottoms as well as vegetation in the banks are a priority. Fertilizer spill prevention, soil testing, split application and slow release P Fertilizer will come in a very important second place. Of the Water control BMP's, the Stop Elevation is critical to avoid sediment transport.
3. This is a high performance farm in the EAA. These deep muck farms present medium P concentration levels in the canals due to their rotation with sugarcane and rice. Since sugarcane is a perennial crop, the soil gets plowed less often than with vegetables or corn, typically once every 4 years. This reinforces soil structure and minimizes soil erosion. The rice cycle will also add stability to the soil because the root system holds it together, increasing its density. When the rice is harvested, the roots become organic matter that promotes bacterial and fungus growth, which are beneficial for bonding the soil particles together. However, even if the rotation is very favorable for the soil, the P-concentration in this type of farms varies drastically with weather. Rain events combined with high drainage capacity can increase the P-Load due to canal dredging. This example farm is also too small to allow for water recirculation instead of drainage. Therefore, the Water Management BMP's are critical to achieve low contents of Phosphorus in the discharges. Priority should be given to Stop Elevations and Water Detention. A deep muck soil can hold plenty of water due to its nature. The canal water levels go down very quickly in muck soils because the water will not move fast from the field to the canals, so when the pumps are started, they will only pull the water of the canal and will not drain the field. This can result in canal dredging and a spike in P-Load. Sediment Control BMP's like vegetation in canal berms and sediment traps in ditches are second in priority. Fertilizer BMP's come in third place because Sugarcane and Rice do not demand great amounts of P- fertilizer.
4. This is a medium performance EAA farm because the drainage infrastructure is a limiting factor. Although these farms have a very favorable rotation scheme, they present high levels of P-Load in their discharges due to an inefficient canal system. Low conveyance due to long, shallow and narrow canals are associated with bottlenecks and canal dredging. It will require to take the water level very low at the pump location, to get the water moving at the far end of the farm. Therefore, this situation ends in over-drainage of fields close the pump station with no significant results in the far away fields. This is aggravated when the rotation with corn takes place. Corn uses more fertilizer and requires good drainage. Therefore, Corn Rotation adds more stress to the system and spikes are very probable during rain events in corn season. The BMP strategy should focus primarily on Sediment Control BMP's through the use of infrastructure. Recirculation and use of booster pumps, as well as canal deepening and cleaning are key to achieve a higher performance in crop yields and water quality. The farm is big enough to recirculate water to fallow and rice fields. This has several advantages. Rotation fields will be closer than the discharge pump because they are scattered throughout the farm. Recirculation water used for rice irrigation saves double pumping because there is no need to take the water out of the farm on one side while pumping for irrigation on the other. Recirculation water can be stored in fallow fields for later use in dry periods. Finally, there is less P-Load and muck leaving the farm because we do not let the water out of the system. Water Management BMP's, especially Start and Stop Elevations are important to minimize water table fluctuations in the fields adjacent to the main pump. Fertilizer BMP's are equally important especially because of the rotation with Corn.

# BMP Workshop

## Example Answers:

5. Farms that are located at the North border of the EAA, adjacent to the L-8 canal share these characteristics. These types of farms have two different areas that require specific management. The sandy soil area with slope is usually dry and erodible and drains into the mucky area which is wet. The sandy soils are unstable with low organic matter and low water holding capacity. The production in sandy soils is limited by irrigation capacity. The slope causes erosion because it makes it difficult to keep the water in the fields and to move water slowly through the canals during a rain event. The mucky area on the other hand, has great water holding capacity and its production is limited by the drainage capacity. However, improving the drainage capacity of the mucky area decreases the potential of the sandy area upland due to over-drainage. Hence, the Sediment Control BMP's should be prioritized through the use of infrastructure. To achieve higher standards of production and water quality, the farm should be separated in two areas through water control structures. The Sandy area with slope will need to set up terraces by joining fields of equal height through leveled canals. The different terraces need stop waters consistent of culverts with raisers. These stop waters are placed in the canals that run with the slope, connecting the high with the low terraces. Booster pumps can be placed to take irrigation water up to the higher terraces. These booster pumps will also alleviate the excess water that accumulates in the mucky fields, down-land. For the Sandy area, the vegetation in canal banks, land leveling and culverts above ditch bottoms are essential. Fertilizer BMP's are also important because sandy soils are prone to leach fertilizer. The Mucky area will prioritize Water Management BMP's like water detention and Start/Stop Elevations and recirculation upland to minimize the amount of water pumped out of the farm.
6. Vegetable operations in the EAA, close to lake Okechobee are in this category of farms. The soils are very rich in organic matter and provide an excellent source of nutrients. When the farm is drained, the water comes out with sediment particles rich in Phosphorus. The BMPs will have the objective of minimizing the movement of water off the farm, however, in small cases like the one of the example, this is not easy to accomplish because there are few fallow fields where to store the excess water. One alternative would be to modify crop rotations to include rice or flooded fallow and add multiple booster pumps to prevent over-pumping. Size is the limiting factor affecting Water Quality, therefore an alternative would be to incorporate this small farm into a bigger Water Management District, where the system as a whole can absorb part of the excess water of this small farm. The farm operator should avoid to grow water level sensitive crops like beans and lettuce in 100% of the farm at the same time. Fertilizer BMP's are second in importance because in a small farm with good drainage, the dissolved Phosphorus can spike the P-concentration. This would be the case of a rain event after an application of soluble P.
7. This is the case of ridges along the L-8 canal and other areas close to the lake Okechobee. These are farms with a very high potential to produce crops, however, due to the sandy soils they need high dosages of fertilizer and water to achieve the maximum. From sustainability perspective, the erosion of this farm is the limiting factor for Water Quality. The sandy soils are unstable with low organic matter and low water holding capacity. The slope causes erosion because it makes it difficult to keep the water in the fields and to move water slowly through the canals during a rain event. These farms which have been through vegetables in the past are very unstable and tend to lose the soil easily. The sediment that comes from these areas is rich in P concentration because of the high fertilizer dosages from the past. Also the past intensive management of the farm has left the soil with poor structure. Main sediment control BMPs for this farm are: canal infrastructure, stepping to control the steep slope, keep banks vegetated (spraying kept to a minimum), add in multiple culverts and booster pumps to take the water up to the sandy soils. Given the size of farm, there are little possibilities for improvement based on rotation crops, however, sandy soils give a better chance of recirculation and percolation of water. Water Detention is key to keep the sediments from leaving the farm. All discharges should be kept to a minimum, once the velocity of the water has been controlled through staging and leveling. Fertilizer BMP's can improve the dissolved P in such a sensitive farm, by applying slow release fertilizers and soil amendments that add structure to the soil. This will ensure higher crop yields and better water quality.

# BMP Workshop

## **Acknowledgements**

The concepts laid out in this workshop come from a variety of sources, but mainly from experiences shared by farm managers of the EAA, researchers from IFAS and officials from the South Florida Water Management District. In appreciation for their support and willingness to share and learn, thank you.

## **Notes and Sources**

Luis Girado has worked in Water Quality at the EAA for 15 years. He holds a BS degree in Agricultural Engineering from University of Buenos Aires, Argentina and a MS degree in Agricultural Economics from Michigan State University in the US.

## **Bibliography**

- Best Management Practices for Florida Vegetables and Agronomic Crops. 2015. Florida Department of Agriculture and Consumer Services.FDACS-P-01268. West Palm Beach, FL.
- Botcher, A.B. and Izuno, F.T. 1993. Procedural Guide for the Development of Farm-Level Best Management Practice Plans for Phosphorus Control in the Everglades Agricultural Area. UFIFAS publication. Belle Glade, FL.
- Bhadha, JH, TA Lang, SM Gomez, SH Daroub, and MC Giurcanu. 2015. Effect of aquatic vegetation on phosphorus loads in the Everglades Agricultural Area. J of Aquatic Plant Management. 53: 44-53.
- Daroub, S. H., Lang, T.A., Diaz, O.A. , and Grunwald, S. 2009. Long-term water quality trends after implementing best management practices in South Florida. J. Environmental Quality. 38:1683-1693.
- Daroub, S.H., Van Horn, S., Lang, T.A and Diaz, O.A 2011. Best management practices and long-term water quality trends in the Everglades Agricultural Area. Critical Reviews in Environmental Science and Technology 41 (6):608-632
- Das, J., Daroub, S. H., Bhadha, J.H., Lang, T. A., Josan, M.S. 2012. Phosphorus release and equilibrium dynamics of canal sediments within the Everglades Agricultural Area, Florida. Water Air Soil Pollution. 223: 2865-2879.
- Hoffman G., Evans R., Jensen M., Martin D., Elliott, R.. Farm Irrigation Systems, 2007. American Society of Agricultural and Biological Engineers. ISBN:1-892769-64-6
- Izuno, F.T., Botcher, A.B., Coale, F.J., Sanchez, C.A., and Jones, D.B. 1990. Agricultural Best Management Practices (BMPs) for Phosphorus Loading Reduction in the Everglades Agricultural Area. UFIFAS. Belle Glade, FL.
- Lang, TA, O Oladeji, M Josan, and SH Daroub. 2010. Environmental and management factors that influence drainage water phosphorus loads from Everglades Agricultural Area farms of South Florida. Agriculture, Ecosystems, Environment 138:170-180
- South Florida Water Management District. 1997. Chapter 40E-61 Florida Administrative Code. Works of the District Basins -- Part I (Lake Okeechobee drainage basin). South Florida Water Management District. West Palm Beach, FL.
- Whalen, Paul J. 1995. Status and verification of the on-going implementation of the Everglades Best Management Practice Program, Water Year 1995. South Florida Water Management District, Everglades Regulation Division. West Palm Beach, FL

# Certificate of Completion



# Selection of Suitable BMPs

## Workshop

Luis M. Girado

Thank You!