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Determination of BMP Adoption Effectiveness in the Louisiana Dairy Production Region

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Determination of BMP Adoption Effectiveness in the Louisiana Dairy Production Region

Abstract

AVGWLF and PRedICT softwares were used to estimate the Louisiana dairy industry's effect on water quality. Results indicated a 20 percent decrease in N and P but little decrease in sediment pollution even when best management practices were adopted in 75% of land.

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Introduction

Dairy farms in Louisiana's Florida Parishes can be considered to be both point and nonpoint sources of pollution. Five southeast Louisiana parishes (Washington, St. Tammany, Tangipahoa, St. Helena, Livingston) contribute over 90% of the dairy products for the state. However, these farms also constitute a large potential threat to the water quality of the area from dairy manure. Chemical compounds that may be necessary for plant growth on a farm may be harmful to nearby water quality. While phosphorus is required for plant growth it harms adjacent water quality if allowed to migrate into that water body. Since sediments, nutrients, pesticides and other contaminates may be washed from agricultural land, various Best Management Practices (BMPs) are designed to mitigate this threat to surface and groundwater (Appendix 1). BMPs are practical ways to ensure that these risks to the environment are reduced without hampering economic productivity.

BMPs are designed to reduce inputs is an important element of pollution prevention. The more a potentially harmful substance is used in agriculture, the more likely it is to negatively affect other parts of the environment. These reduction BMPs are tied most directly to fertilizers, manures and pesticides. Commonly recommended BMPs in the dairy production region of Louisiana are shown in Appendix 1.

The United States Department of Agriculture (USDA) recognized that agricultural chemicals and sediment from cropland could reduce the water quality of America's surface and groundwater and instituted the Clean Water Act. While this act stipulates that individual states are responsible for controlling agricultural nonpoint pollution, the USDA installed both voluntary and mandatory policies to encourage farmers to adopt BMPs to address pollution issues.

Voluntary policies use an incentive to encourage the farm operator to adopt less polluting technologies and have been the primary approach used to reduce nonpoint source pollution. Two of the most common voluntary methods to encourage farmers to adopt less polluting practices are cost sharing and incentive payments.

Involuntary incentives force the farmer to use pollution-control methods through higher input costs or direct regulation. Taxes raise the price of an input to encourage less use and drive down pollution. Another involuntary method to reduce pollution is regulations. Direct regulation is the most common involuntary method and requires farm operators to meet minimum design standards for certain pollution technologies or minimum performance standards for emission levels.

The objectives of this paper are:

i) Given a suite of Best Management Practices (BMPs), which BMP combination incur the least cost while still meeting the required nutrient water standards in dairy producing region of Louisiana.

ii) Evaluate three levels of pollution reduction scenarios and make recommendations for policy makers.

Methodology

To accomplish the objectives of this study; an analysis is needed to determine if the BMP adoption resulted in significant improvement in water quality in the region. The use of GIS-based software was crucial in this determination. The tool used was AVGWLF (Average Watershed Loading Function) developed to derive input for an "impaired" watershed and compare it to a nearby "reference" watershed through simulation. AVGWLF uses "layers" of information of accomplish this goal. Of course, the most important layer is the location of dairy farms. Additional layers are: weather, point sources of pollution, watersheds, basins, streams, unpaved roads, paved roads, county (parish) boundaries, septic systems, animal densities, soil types, and elevation data.

For our initial analysis, we choose a section of northern Tangipahoa Parish that included six subsection of the major watershed where a significant portion of dairy farms within the parish are located. These six subsections then formed a basin aggregate (Basin Aggregate 1). Our initial efforts for the study then focused on the layers of information within Basin Aggregate 1.

After the layers for Basin Aggregate 1 are entered, the AVGWLF application is used to create input data files for subsequent use in the Generalized Watershed Loading Function (GWLF). This model simulates runoff, sediment, and nutrient (N and P) loadings from a watershed given the agricultural, forested, and developed land available. In addition, it contains algorithms to calculate septic system loads and point source discharge data. GWLF is a continuous simulation model that uses daily time steps for weather data and water balance estimations. Daily water balance is accumulated into monthly amounts and these calculations result in sediment and nutrient loads.

These estimates are then loaded into the Pollution Reduction Impact Comparison Tool (PRedICT). This model was developed for use in evaluating the implementation of agricultural and non-agricultural pollution reduction at the watershed level. The user can create scenarios for current versus future landscape conditions and pollution loads and predicts the reduction in pollution in the watershed on the different scenarios. BMP implementation for pollution reduction is enacted at this point. The BMPs are group into eight categories: cover crops, conservation tillage, conservation plans, agricultural to forest conversion, agricultural to wetland conversion, nutrient management, grazing land management, a user defined BMP.

Data and Study Area

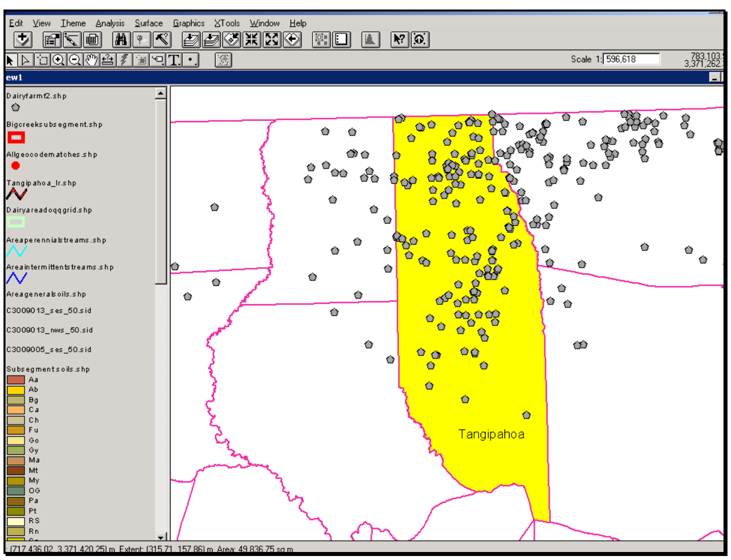
Data were collected from a survey sent to all 344 Louisiana dairy farms using a mail survey following the tailored designed method (Dillman, 2001). The survey contained four sections: Dairy Manure Disposal, the Dairy Termination Program (DTP) and the Milk Diversion Program (MDP) as policy instruments to reduce cow numbers so as to control the negative environmental impacts of cow manure, BMP adoption as measures to enhance the cow carrying capacity of the land without compromising the environment, and demographics.

Surveys were mailed first on May 2004 and then follow up surveys were mailed again after three weeks. After two weeks of mailing the survey, a reminder post card was mailed to each individual whom the survey questionnaires were mailed. In addition, telephone contact attempts were made to encourage responses. Only 49 surveys were received for a response rate of 14.24%. The low response rate reflects several aspects of current dairy production. The industry is in decline in Louisiana and some farmers on the mailing list were either out of business or had retired. In conversation with the farmers, many expressed a feeling that they were being constantly survey and were tired of the process. Several farmers felt that nothing good ever came out of such surveys because the price for their milk just keeps falling.

The survey determined BMP adoption among farmers through the use of thirteen adoption questions. For example, waste treatment lagoons and cover and green manure crop participation rates were determined. If a BMP was not under current adoption, the farmer was asked to determine the level of total costs that he/she would pay to adopt.

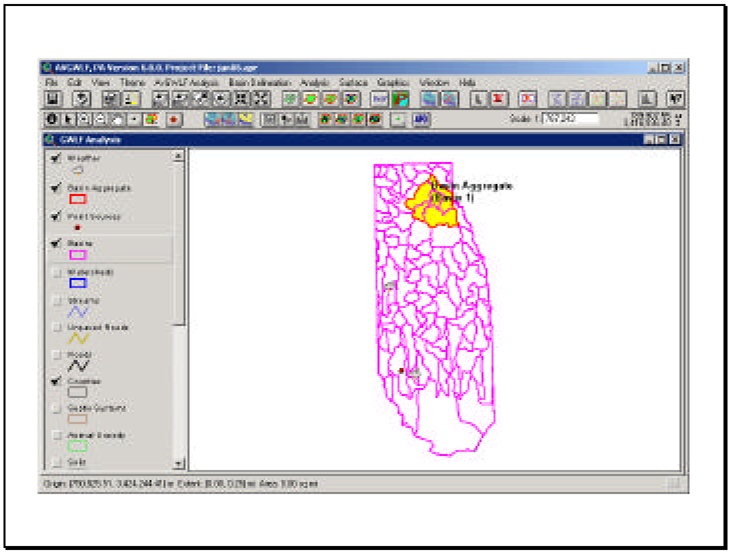
Results

Figure 1.



The first step in using AVGWLF is to add information "layers." Figure 1 shows the location of dairy farms in Tangipahoa parish. Other layers include weather data, streams, unpaved roads, paved roads, point pollution sources, watersheds, animal density, soils, and elevation.

Figure 2



Six sub-watersheds are chosen that included a large number of the dairy farms. These six sub-watersheds are the aggregated into a Basin Aggregate (Basin 1) as shown in Figure 2.

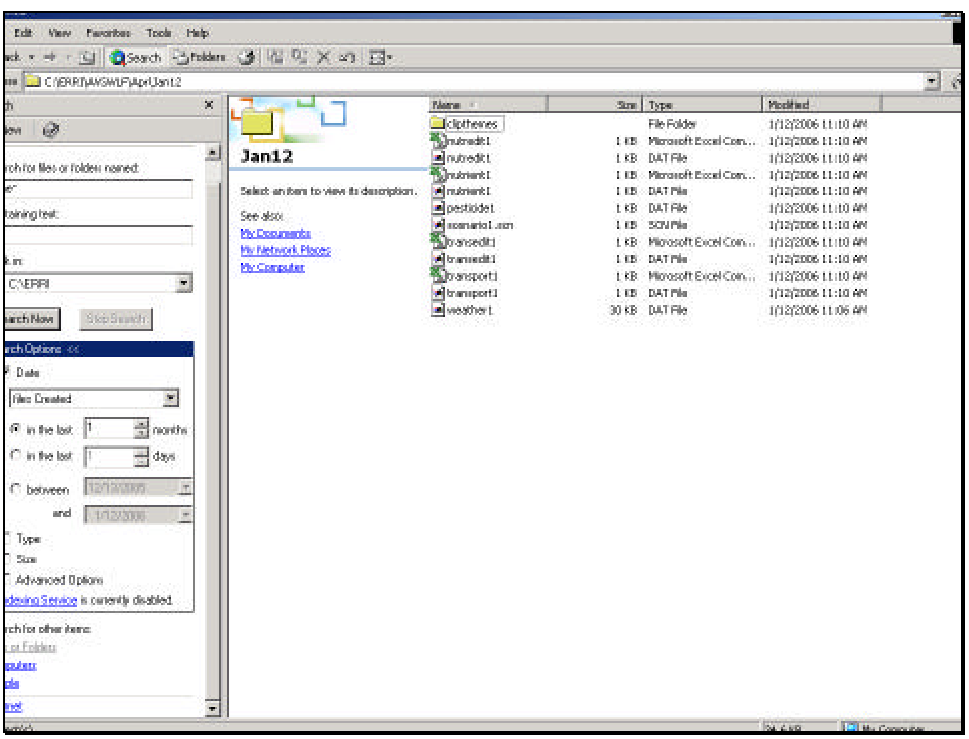
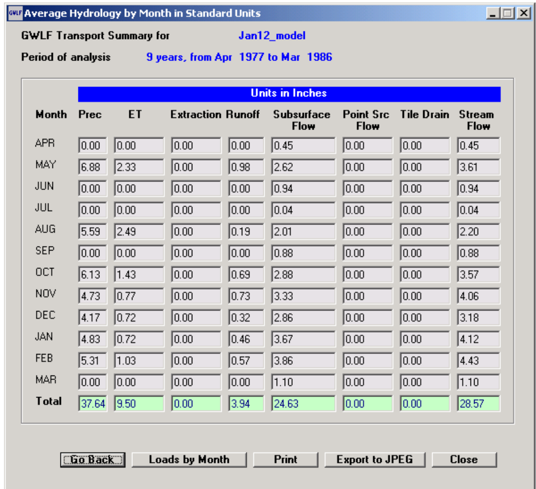


Figure 3 shows the layers of data (nutrient, pesticides, transportation, and weather) that will be transferred to GWLF for further processing.

Figure 4



Average Hydrology by Month in Standard Units

GWLF Transport Summary for Jan12_model

Period of analysis 9 years, from Apr 1977 to Mar 1986

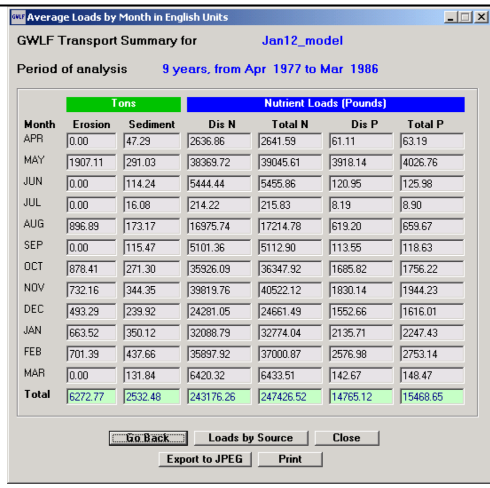
Units in Inches

Month	Prec	ET	Extraction	Runoff	Subsurface Flow	Point Src Flow	Tile Drain	Stream Flow
APR	0.00	0.00	0.00	0.00	0.45	0.00	0.00	0.45
MAY	6.88	2.33	0.00	0.98	2.62	0.00	0.00	3.61
JUN	0.00	0.00	0.00	0.00	0.94	0.00	0.00	0.94
JUL	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.04
AUG	5.59	2.49	0.00	0.19	2.01	0.00	0.00	2.20
SEP	0.00	0.00	0.00	0.00	0.88	0.00	0.00	0.88
OCT	6.13	1.43	0.00	0.69	2.88	0.00	0.00	3.57
NOV	4.73	0.77	0.00	0.73	3.33	0.00	0.00	4.06
DEC	4.17	0.72	0.00	0.32	2.86	0.00	0.00	3.18
JAN	4.83	0.72	0.00	0.46	3.67	0.00	0.00	4.12
FEB	5.31	1.03	0.00	0.57	3.86	0.00	0.00	4.43
MAR	0.00	0.00	0.00	0.00	1.10	0.00	0.00	1.10
Total	37.64	9.50	0.00	3.94	24.63	0.00	0.00	28.57

Go Back | Loads by Month | Print | Export to JPEG | Close

Figure 4 contains precipitation, evaporation, extraction, runoff, subsurface floe, point source flow, tile drain, and stream flow calculated by GWLF.

Figure 5



Average Loads by Month in English Units

GWLF Transport Summary for Jan12_model

Period of analysis 9 years, from Apr 1977 to Mar 1986

	Tons		Nutrient Loads (Pounds)			
Month	Erosion	Sediment	Dis N	Total N	Dis P	Total P
APR	0.00	47.29	2636.86	2641.59	61.11	63.19
MAY	1907.11	291.03	38369.72	39045.61	3918.14	4026.76
JUN	0.00	114.24	5444.44	5455.86	120.95	125.98
JUL	0.00	16.08	214.22	215.83	8.19	8.90
AUG	896.89	173.17	16975.74	17214.78	619.20	659.67
SEP	0.00	115.47	5101.36	5112.90	113.55	118.63
OCT	878.41	271.30	35926.09	36347.92	1685.82	1756.22
NOV	732.16	344.35	39819.76	40522.12	1830.14	1944.23
DEC	493.29	239.92	24281.05	24661.49	1552.66	1616.01
JAN	663.52	350.12	32088.79	32774.04	2135.71	2247.43
FEB	701.39	437.66	35897.92	37000.87	2576.98	2753.14
MAR	0.00	131.84	6420.32	6433.51	142.67	148.47
Total	6272.77	2532.48	243176.26	247426.52	14765.12	15468.65

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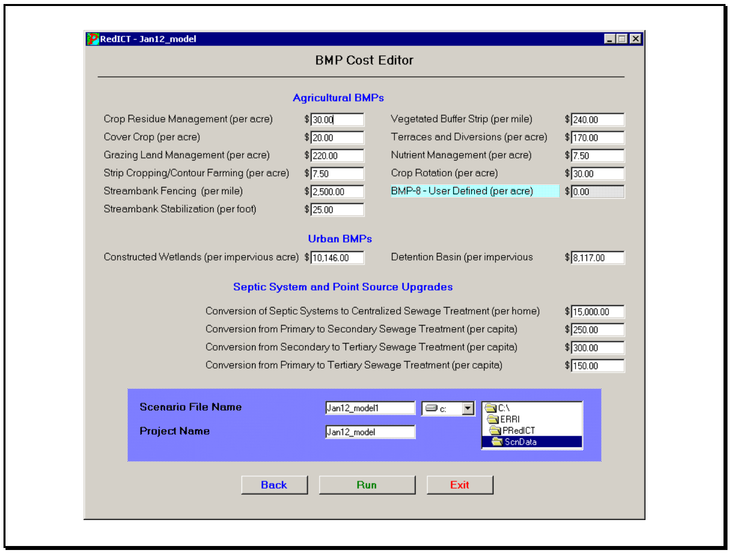
Figure 5 shows tons of erosion, sediment, dissolved nitrogen, total nitrogen, dissolved phosphorus and total phosphorus for a nine year period by month calculated using GWLF.

Figure 6



After the GWLF calculations, the data is input for use in PRedICT. Figure 6 shows cost information by BMP. PRedICT allows for BMP manipulations to estimate the effect of BMPs on pollutants in Aggregate Basin 1.

The summary nutrient reduction results are as follows:

	BMP Usage			
	0%	25%	50%	75%
Total Sediment (lbs)	1,052,456	1,000,253	1,001,412	991,835
Total Nitrogen (lbs)	102,569	94,673	85,832	81,120
Total Phosphorus (lbs)	12,087	11,465	10,942	10,573

This study focused on three different future scenarios then compared an existing situation of zero BMPs with a 25%, 50% or 75% BMP implementation. The total for BMPs #1 to BMP #5 cannot be greater than 100%. BMP #5 (agriculture to wetland conversion) can only be applied to lands with a slope greater than 3% and was limited to 5% increase in the program. There were two major agricultural acre types: row crops and hay/pasture. Dairy production falls under hay/pasture and is not predicted by using BMP # 1 (cover crops) and BMP # 2 (conservation tillage).

Not all BMPs are expected to reduce pollution by the same amount. For example, BMP # 6 (nutrient management) reduces nitrogen by 70% and phosphorus by 28% but doesn't affect sediment. BMP #7 (grazing land management) reduces nitrogen by 43%, phosphorus by 34% and sediment by 13%.

While Nitrogen and Phosphorus both deceased with increases in BMPs sediment didn't actually increased slightly. Since BMP # 5 was limited to 5%, BMP # 6 was increased to 15%, which may have lead to the slight increase in sediment. However, all three variables decreased at the 75% level.

Conclusions

Implementation of BMPs showed reduced pollution in three simulation scenarios for a small watershed basin in northern Tangipahoa Parish, Louisiana. Both nitrogen and phosphorus pollutants were reduced approximately 20% with a 75% increase in BMP usage. However, sediment pollution remained high even with the improved BMP implementation. While pollution reduction was achieved, cost increases significantly as the desired level of nutrient water quality increases (Table 1). Cost changes as the desired suite of BMP is modified from $ 642,238.5 to $1,621,389. The results show diminishing returns with BMP adoption. Therefore, policy makers funding for a 25% adoption would achieve almost half of the pollution reduction for approximately one-third of the cost of what would be achieved with a 75% adoption. Further study will include all five dairy producing parishes in Louisiana and their impact on regional water quality.

References

Dillman, D.A. Mail and Internet Surveys: The Tailored Design Method, John Wiley and Sons, Inc., New York, 2000.

Evans, B, Lehning, D., Borisova, T, Corradini, K, Sheeder, S., Brown, W. AVGWLF and PRedICT Manuals, Penn State Institute of the Environment The Pennsylvania State University.

Hilliard, C and Reedyk, S "Agricultural Best Management Practices" Accessed from the web http://www.agr.gc.ca/pfra/water/agribtm_e.htm on January 9, 2006

Feather, P. and Cooper, J. "Voluntary Incentives for Reducing Agricultural Nonpoint Source Water Pollution" Accessed from the web Http://www.ers.usda.gov on January 9, 2006

Table 1

BMP	BMP%	Hay/Pasture Acres	Cost/Acre	Total Cost	Sediment (lbs)	Nitrogen (lbs)	Phophorus (lbs)
3	0	28076	30	0	1052456	102569	12087
4	0	28076	30	0	1052456	102569	12087
5	0	28076	170	0	1052456	102569	12087
6	0	28076	7.5	0	1052456	102569	12087
7	0	28076	220	0	1052456	102569	12087
Total %	0		Total Cost	0			
3	0.05	28076	30	42114	1008253	94673	11465
4	0.05	28076	30	42114	1008253	94673	11465
5	0.05	28076	170	238646	1008253	94673	11465
6	0.05	28076	7.5	10528.5	1008253	94673	11465
7	0.05	28076	220	308836	1008253	94673	11465
Total %	25		Total Cost	642238.5			
3	0.1	28076	30	84228	1001412	85832	10942
4	0.1	28076	30	84228	1001412	85832	10942
5	0.05	28076	170	238646	1001412	85832	10942
6	0.15	28076	7.5	31585.5	1001412	85832	10942
7	0.1	28076	220	617672	1001412	85832	10942
Total %	50		Total Cost	1056360			
3	0.17	28076	30	143187.6	991835	81120	10573
4	0.18	28076	30	151610.4	991835	81120	10573
5	0.05	28076	170	238646	991835	81120	10573
6	0.18	28076	7.5	37902.6	991835	81120	10573
7	0.17	28076	220	1050042	991835	81120	10573
Total %	75		Total Cost	1621389			

BMP 3 Conservation Plans (Crop Rotation/acre)
BMP 4 Agricultural to Forest Conversion (Crop Residue Management/acre)
BMP 5 Agricultural to Wetland Conversion (Terraces and Diversions/acre)
BMP 6 Nutrient Management/acre
BMP 7 Grazing Land Management/acre

Appendix 1

Types of generic BMPs aggregated for use in the PRedICT system

1) Crop Residue Management
2) Vegetated Buffers
3) Crop Rotation
4) Cover Crops
5) Contour Farming/Stripcropping
6) Terraces and Diversions
7) Grazing Land Management
8) Streambank Protection
9) Nutrient Diversion