Least Cost Selection of BMPs in the Fort Cobb watershed

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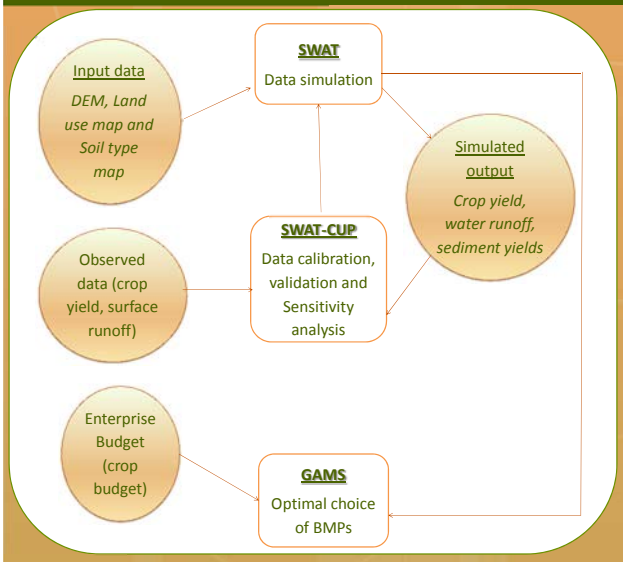
Abstract

The main cause of water quality impairment in the Unites States is due to Non-Point Source (NPS) pollution caused by human activities like agriculture and urbanization. An example is the Fort Cobb Watershed which has limited capability due to soil erosion and phosphorus load. Extensive conservation practices such as strip cropping, no-tillage management, conservation of cropland to grassland have been implemented in the Fort Cobb Reservoir watershed. The objective of this research is to determine the most cost effective selection of Best Management Practices (BMPs) on farmland to reduce soil erosion and the delivery of sediment and phosphorus to the reservoir. Detailed conservation practices were simulated with SWAT to determine yields, erosion, and phosphorus loss for each practice by each HRU (a soil type-land use unit) and location in the watershed. The results indicate that the cost of preventing 75% of additional ton of sediment is 41.6 $/ton and the combination of contour farming, and terraces are the most cost efficient BMPs in farmlands.

Introduction

Soil erosion is a major environmental problem which threatens the sustainability and productive capacity of agriculture. Continuous excessive erosion which causes thinning of soils, removes plant nutrients, and changes soil properties jeopardizes the sustainability of high levels of crop production. In addition to reduce crop productivity, too much sediment in surface water supply may result in taste and odor problems and can shield pathogens from the action of disinfectants during treatment. Sediment deposition on streambeds and lake bottoms reduces spawning areas, aquatic organism food resources, and habitat complexity, as well as increasing dredging costs on larger rivers and reservoirs. To address these problems, Several conservation practices have been implemented in the Fort Cobb Reservoir watershed including adoption of no-tillage management, conservation of cropland to grassland, crop rotation, strip cropping, contour and terrace farming, cattle exclusion from streams, and various structural and water management practices (Becker and Steiner, 2011). Identifying the most-effective in-stream, streambank, and riparian conservation practices will help build an educational program. This program will include educating farmers, landowners, natural resource managers, policy-makers and youth in and around the Fort Cobb watershed about management that improve water quality while maintaining a substantial income to farmers.

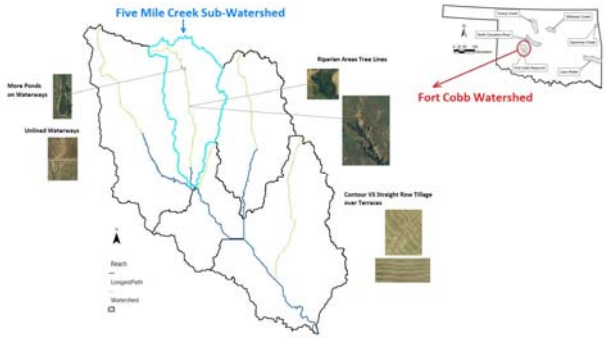
Methods & Procedure



Study area:

Study area: The Fort Cobb Watershed is located in the Central Great Plains Ecoregion in central western Oklahoma in Caddo, Washita, and Custer Counties in the Upper Washita sub sub-basin.

Objective function:



Price of Crop I

Yield of $Crop_i$ on HRU_j under each scenario

Forage Value for $Crop_i$

Total Cost to produce $Crop_i$ under each scenario

Phosphorus runoff from HRU_j under $Crop_i$ and each scenario

Nitrogen runoff from HRU_j under $Crop_i$ and each scenario

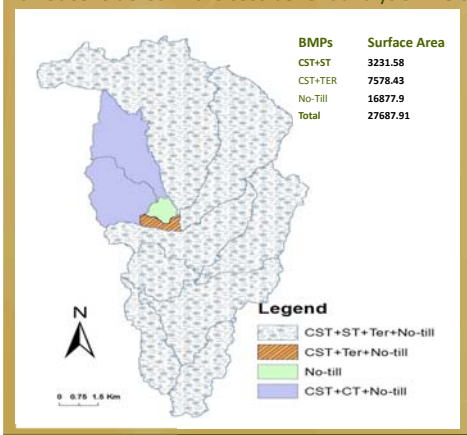
Sediment runoff from HRU_j under $Crop_i$ and each scenario

Acres in HRU_j

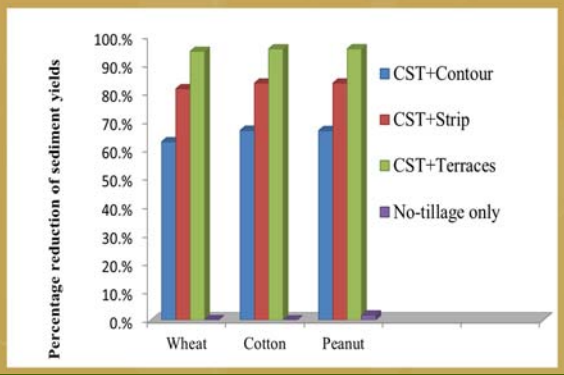
The Variable: the number of acres of Crop I in HRU_j

Results

Conservation tillage plus terraces is more efficient in reducing sediment loads. The Cost Effectiveness analysis based on Cost per ton of Erosion Abated (CEA) shows that contour farming and strip cropping are more cost efficient as compared to conservation tillage alone. No tillage farming has the higher net return for farmers when soil erosion is not considered in the cost-benefit analysis. The combination of contour farming, strip cropping and terraces is the optimal option for reducing pollutant load from uplands.



Percentage of sediments reduction from baseline



Cost per percentage of sediment reduction

Percentage	Cost per percentage sediment reduction
50%	251,850
75%	559,556
95%	1,129,749

Shadow prices in dollars

Target	Sediment ($/ton)	Nitrogen ($/Kg)	Phosphorus ($/kg)
T-0-0-0	0.00	0.00	0.00
T-50-50-50	23.02	15.68	145.40
T-75-75-75	41.96	23.75	215.38
T-95-95-95	78.29	38.31	357.28

Conclusion

1. SWAT shows a reasonable performance in simulating surface runoff, sediment loads, nitrogen and phosphorus
2. In reference to conservation tillage, contour farming and strip cropping and terracing are more effective in reducing soil erosion than no-till farming alone
3. No-till farming is the most economical in terms of profit maximization with disregards to sediment reduction
4. Terracing is the most effective in reducing soil loss but yet expensive