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MAPPING POTENTIAL CRP LAND AND DETERMINING CRP PROFITABILITY IN LANCASTER COUNTY

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Abstract

Annually 17 tons of soil is lost due to the erosion of agriculture land. A majority of the soil lost is fertile topsoil, which can render the land unproductive. The Conservation Reserve Program (CRP) was enacted to reduce the high erosion rates on agriculture land by giving landowners a monetary incentive to let their land lay idle and allow the soil to regenerate. Although there is awareness of the benefits of CRP, little effort has been put toward delineating CRP eligible land. In this project, Geographical Information Systems were used to map CRP eligible land in Lancaster County, Nebraska based on guidelines set by the Farm Service Agency. Also, this project determined the point where it becomes profitable to enroll in CRP based on current yields and input costs. It was found that at current commodity prices it is more profitable to leave land in production. However, when landowners are considering CRP the maps can aid them in their decision and give them an estimate of their price per acre. It can also be of use to the FSA when deciding what land should have priority. To continue this study it would be useful to repeat it over all the counties in Nebraska to ensure the long-term productivity of the state.

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Introduction

Erosion:

Each Year, 75 billion metric tons of soil is lost as a result of erosion. A large portion of the soil lost is topsoil, stripping the land of productivity (Pimental 1995). This high rate of erosion can be attributed to many factors, with agriculture being the leading cause. In the United States, an average of 23 tons of soil per hectare is lost annually on agriculture lands with cropland being the main contributor accounting for 17 of the tons (USDA 1989). There are two different types of erosion that soil left bare is susceptible to, wind and water. These two erosion processes are continually being enhanced because of unsuitable, high slope areas being converted to cropped lands removing cover that holds soil in place (Pimental 1995). In 1985 the federal government implemented the Conservation Reserve Program to rectify the degradation of otherwise productive soil (Food Security Act 1985).

The Conservation Reserve Program:

The Conservation Reserve Program (CRP) is a voluntary program designed to give agriculture landowners an incentive to let their land lay idle. Farmers receive rental payments and cost-share assistance to offset the cost of taking their land out of production and converting it to natural habitat (FSA 2011). The less intensive land use can be pasture, permanent grass, legumes, forbs, shrubs, or trees (Food Security Act 1985). The ultimate intensions of the CRP are to reduce water and wind erosion, protect long-term capability to produce food and fiber, reduce sedimentation, improve water quality, create better habitat for fish and wildlife through improved food and cover, curb production of surplus commodities and provide needed income support for farmers (Reichelderfer et al 1988). For land to be eligible to be part of the CRP there are many requirements that must be met to ensure the most sensitive land has the highest

priority. First, the producer must have owned or operated the land for at least 12 months prior to the sign-up period. Second, the land must be planted, or considered planted to an agricultural commodity four of the six cropping years from 2002-2007. Third, the land must be physically capable of being planted in a normal manner to an agricultural commodity. Lastly, the area must have weighted average erosion index (EI) of 8 or higher, be expiring CRP acreage, or be located in a national or state CRP priority area (FSA 2011). The EI constructs a graduated way to classify the erodibility of soil, with 0 being relatively stable soil and increasing as the potential for erosion increases (Reichelderfer et al 1988). When all of these requirements are met the Farm Service Agency (FSA) will select the highest ranked offers.

Objectives:

Although there is awareness of the vast environmental benefits and the potential economic paybacks, there has been little effort put towards the delineation of CRP eligible land (Nellis et al 1996). The first objective of this project is to use Geographic Information Systems (GIS) applications to identify land within Lancaster County, Nebraska that are eligible for entry into the CRP based on factors developed by FSA. The second goal is to determine at what point it is profitable for land owners to apply for enrollment with the CRP.

Literature Review

Over recent years there has been a growing interest in classifying land cover and soil types to be applied to various CRP uses. Egbert et al, 1998 realized the growing need for and lack of digital CRP maps for legislators, farmers, economists and scientist to utilize for making future decisions regarding the CRP. In this study researchers apply moderately high resolution imagery to map CRP and cropland over a large area of land. To do this they used image analysis and (GIS) to make their classifications. Prior to Egbert's article, researchers have utilized single date imagery to determine land cover, for it is the most affordable and accessible data. However, in this study Egbert and others apply multi-temporal imagery for improved results (Egbert 1998). When developing another method for mapping CRP land, Song et al made use of single-date Landsat Thematic Mapper satellite imagery. For this project, single-date landcover data will be used because of the need for a repeatable model that can be applied to other counties throughout the state and beyond.

A similar study was conducted by Park et al, 2005 employing GIS techniques to extract soil characteristics of various land-use types. Here they utilized landcover maps that had been classified in the past to perform their research. Park uses the US Department of Agriculture's (USDA) Natural Resources Conservation Service's (NRCS) Soil Survey (SSURGO) data to determine soil erodibility within the study area. The SSURGO database contains the characteristics of all soil series' and their spatial distribution. From the SSURGO information the EI can be determined for each soil type (Park 2005). The use of past classified landcover to determine cropped and non-cropped land and the use of SSURGO data for soil erodibility as presented by Park and others will be used to determine CRP eligibility within Lancaster County.

While there are articles focused on mapping CRP there are few that analyze the economic benefits or losses to the land owners and many focus only on economics surrounding the natural resources. Feather et al, 1999 focused on how the costs and benefits affect the public and private sectors. The two sectors are vital to assessing the success of the CRP, however they do not assist the farmer when deciding whether or not to place land into CRP. They do briefly mention that the on-farm income is $20,300 through the CRP. However, they do not mention how this number was derived or take into account the loss of income that is possible from taking land out of commodity production. While the environmental and the long term economic benefits of CRP are valuable, it is also important to evaluate the economic benefits to the individuals most directly affected.

Materials and Methods

Location and Approach:

The location for this project is Lancaster County, positioned in southeast Nebraska (Fig 1). Lancaster County has a strong agriculture influence that is very prone to soil erosion, making it an optimal area for land to be converted into CRP. The tool used for delineating eligible CRP land is ArcGIS 10 produced by ERSI. ArcGIS and ArcMap make it possible to quantitatively and spatially analyze and illustrate information.

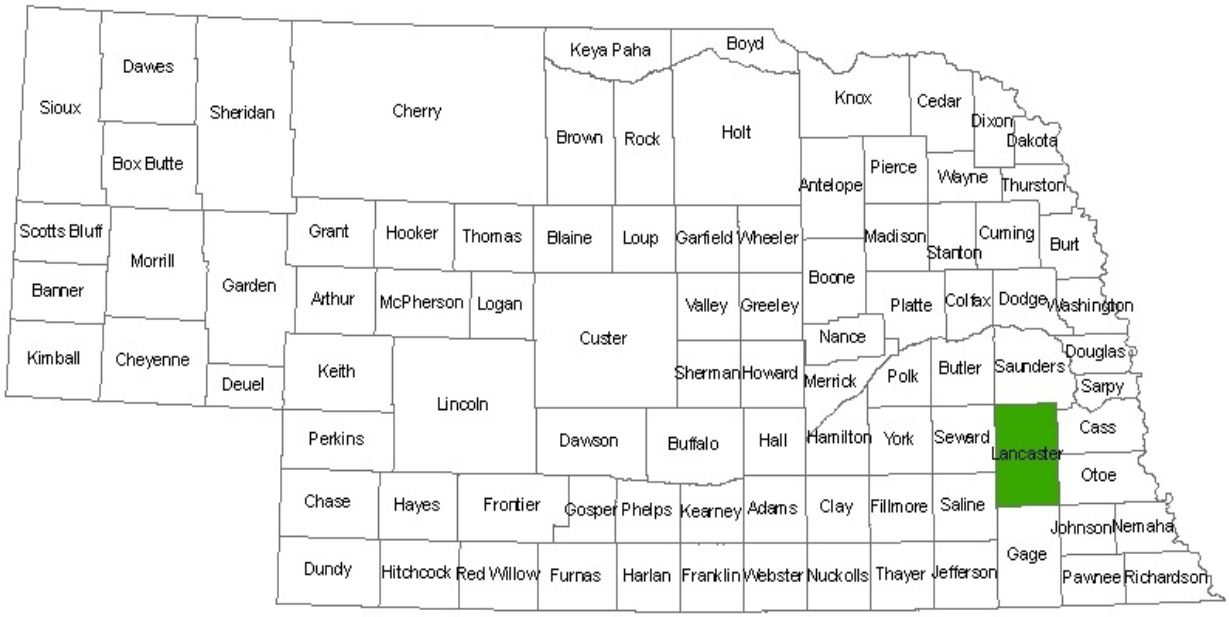

Figure 1: Study location. Lancaster County, Nebraska.

CRP Eligibility Delineation:

To begin determining CRP eligibility, land cover imagery of 2005 from the Center for Advanced Land Management Information Technologies (CALMIT) was obtained (Fig 2). The image is a product of the Landsat 5 satellite imagery. From the imagery, 25 land use classes were delineated by CALMIT with the help of field cover data from the Nebraska Natural Resources District and the Nebraska Department of Natural Resources. One criterion for CRP eligibility is that land is considered planted to an agricultural commodity. For this project it is assumed that areas regarded as cropland in 2005 has also been in agriculture production the additional 3 years. When the image was uploaded into ArcMap 10 there were a number of fine, scattered pixels. For this project the smallest pixels are irrelevant because many are non-agriculture land uses or too small to be considered applicable. To remove the finest pixels the tool Majority Filter was applied twice to replace the small cells in a raster

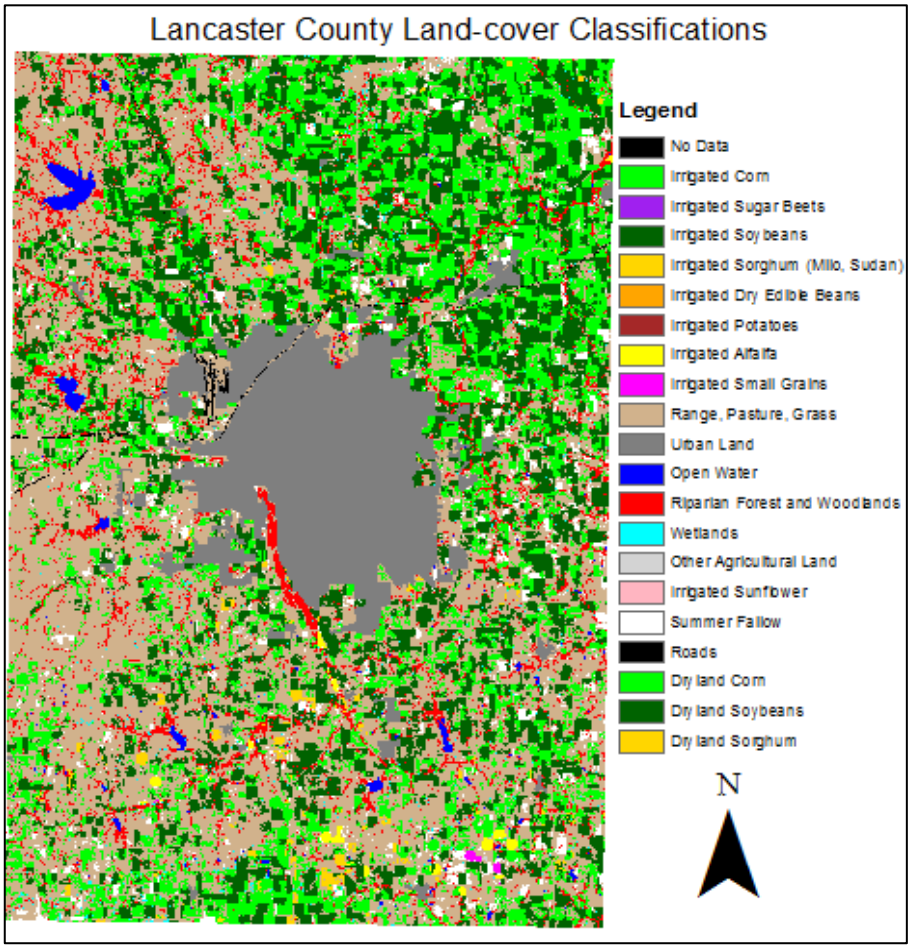

Figure 2: Lancaster County Landcover Classifications as delineated by CALMIT and others.

file based on the majority of their contiguous neighboring cells. After using the Majority Filter it was easy to combine the land uses into the 3 classes of interest; irrigated agriculture, dryland agriculture and non-agriculture land using the Dissolve tool. The Dissolve tool combines features based on specified attributes. For example, the initial land cover classifications of irrigated corn, soybeans, sorghum, sunflower, alfalfa, sugar beets, dry edible beans, potatoes and small grains were combined into one feature, irrigated agriculture. The same was repeated for dryland agriculture classification using original classifications of rainfed corn, soybeans, sorghum, dry edible beans, alfalfa, small grains and sunflower. The remaining classes were pasture and non-agriculture which consists of urban land, open water, riparian forest, woodland, wetlands, roads and barren land.

The second file used was soil data for Lancaster County which is produced by the Natural Resource Conservation Service, Soil Survey (Fig 3). The information provided by the soil survey that is relevant to this project is the musym number. The musym number is a map unit symbol expressed in a number that represents a specific soil series. The Farm Service Agency (FSA) has predetermined a price per acre for the soils with the highest potential for erosion. The soil types that are suitable for CRP have an EI of 8 or higher, and the EI is factored into the FSA's price per acre. There are six FSA price brackets the soils can fall in, $80, $89, $98, $110, $123 and $133, with $80 being the least erodible and $133 being the most. Not all soil types within Lancaster County have an EI of 8 or higher and therefore are not qualified for CRP. The prices for the eligible land were entered with their corresponding soil types and the soils left without a dollar amount were deleted. Then the soil series' were dissolved by price per acre, so that the final soils map was organized by price classes.

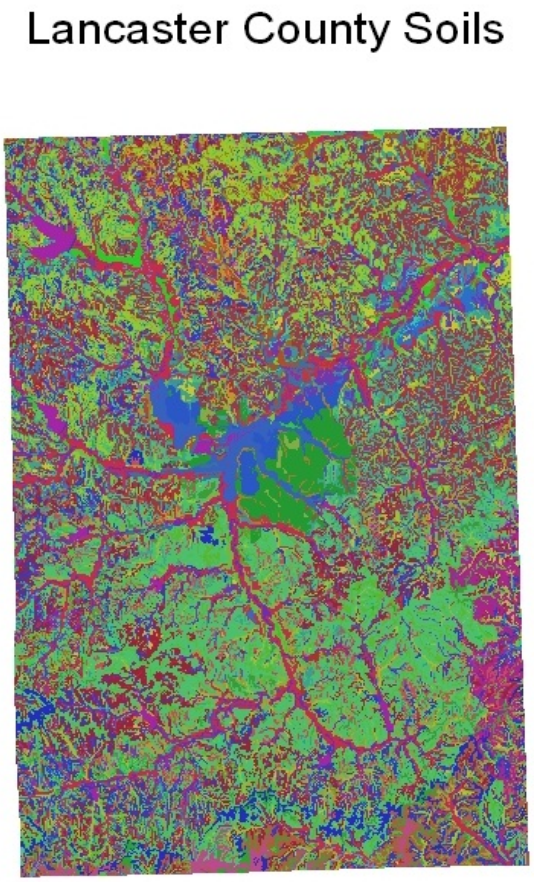

Figure 3: Soil SSURGO data. Separated by musym number.

At this point, the land use map defines locations in Lancaster County that are cropland and non-agriculture and the soils maps shows where highly erodible soils are located and how many dollars per acre they are worth. Next, these two shapefiles were combined using the Union tool to produce one map that includes all attributes of the two. The Union tool computes a geometric intersection of the soil and landuse features for the creation of one combined feature. For this project only agriculture land and land that has an assigned dollar value are of importance, therefore the next step was to delete the polygons that contained land worth $0 and non-agriculture land. The last requirement for CRP is that land is contained within the priority area of Lancaster County. The majority of Lancaster County is part of this area aside from the southeast corner. To account for priority area, the small section of southeast Lancaster County was removed from the map. The resulting map includes land that is cropped, has an EI of 8 or higher and is within the priority area, covering the requirements necessary to be considered for the CRP.

Profitability:

The second objective was to determine when, if at all, farmers are able to turn a profit from CRP instead of leaving their land in production. To do this, profit per acre of irrigated and dryland crops must be determined and compared to the profit per acre that CRP offers. The two cash crops that occupy the most area within Lancaster County are corn and soybeans. Therefore, the yields of these two crops under dryland and irrigated conditions were utilized to produce the profit information for land in production. The equation for calculating the profit of an acre of cropped land is price per bushel times yield in bushels per acre minus average input cost; ($/bu*bu/acre)-input cost/acre=profits. The price per bushel of soybeans and corn was obtained from the USDA National Agriculture Statistics Service, the rate that was chosen came from the average of the 2011 April and March prices. Open enrollment for CRP is between the months of March and April, making these dates critical to the land owners to decide whether to apply or continue producing crops. The average bushel per acre and the average input costs were derived from statistics from the 2011 NebGuide "Crop Budgets", a publication produced by the University of Nebraska-Lincoln Extension that publishes research-based and peer-reviewed information regarding agriculture and natural resources. The Crop Budget publication defines different farming practices, the average bushel per acre produced by the practices and the average input costs of the practices. A few of the different practices that affect the yield include tillage choice, use of Roundup ready seed, and rotation patterns. Influential factors for the input cost include fertilizer, herbicide and insecticide amount and application, as well as harvesting, seed and labor costs. To account for all practices and variability within Lancaster County an average of yield and input cost over all farming practices was calculated for irrigated and rainfed corn and irrigated and rainfed soybeans. The crop price, yield and input cost were entered into

the profit equation in Microsoft Excel 2010 and calculated to produce the estimated average profit in dollars per acre to be compared against the dollars per acre offered by CRP.

Results and Discussion

CRP Eligibility:

The FSA states that land must be in agriculture or capable of being planted to be considered for CRP. It is clearly seen that dryland farming is the dominate agriculture practice within Lancaster County (Fig 4). Dryland agriculture covers 214619.21 acres as compared to irrigated at 14847.04 acres.

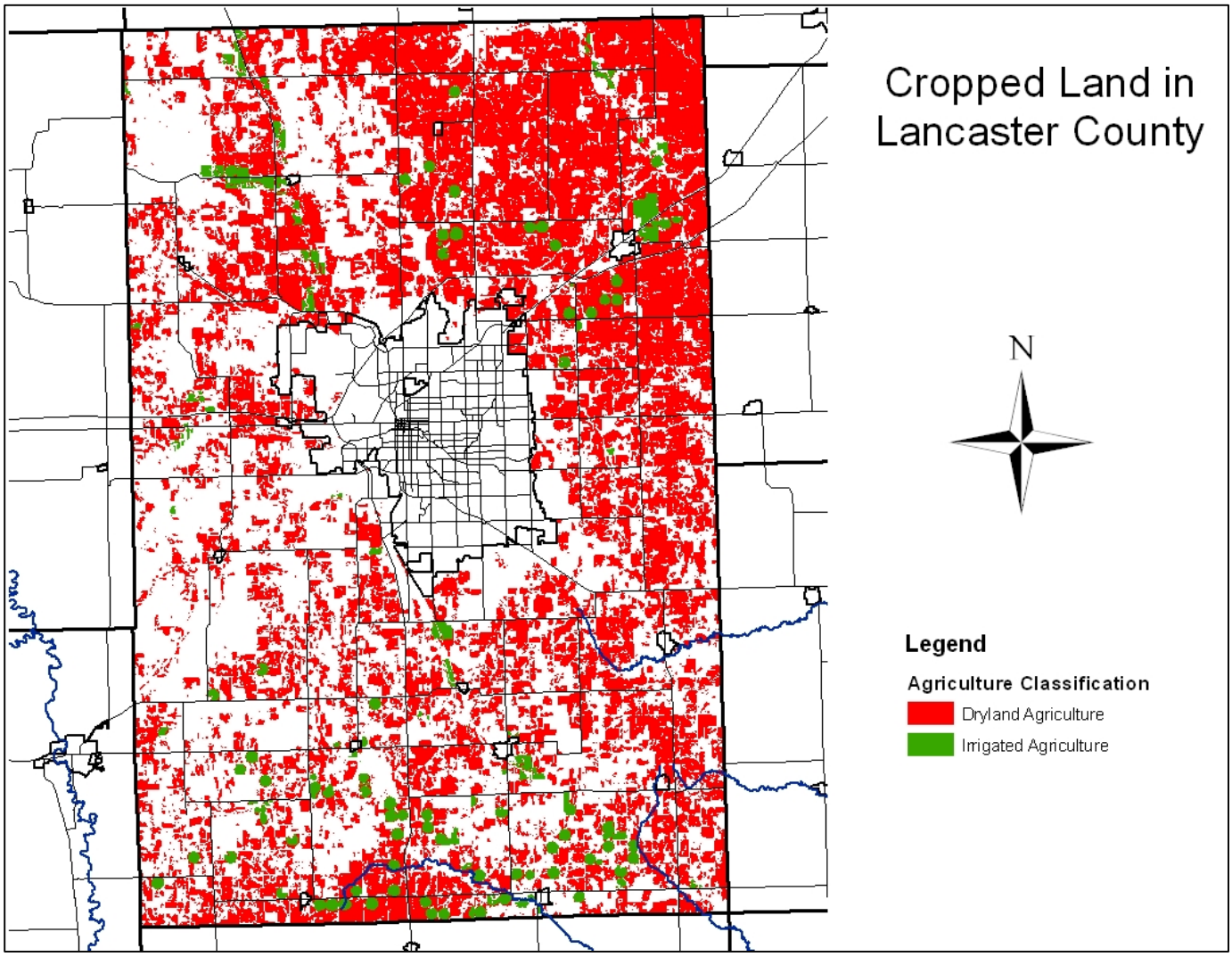

Figure 4: Cropped land separated into irrigated and rainfed areas.

The majority of the land in Lancaster County have a rental rate of $110 or higher (Fig 5). The high rental rate areas have the highest EI values making them more vulnerable to erosion than the others and therefore there is more incentive for them to be protected. The FSA determines the rental rate for a tract of land by defining the 3 major soil types within the land of interest and then averaging the rental rates of the 3 to calculate the price per acre the land owner would receive. When farmers want to quickly get an estimate of their possible rental they can refer to the map in Figure 5 to derive an estimation.

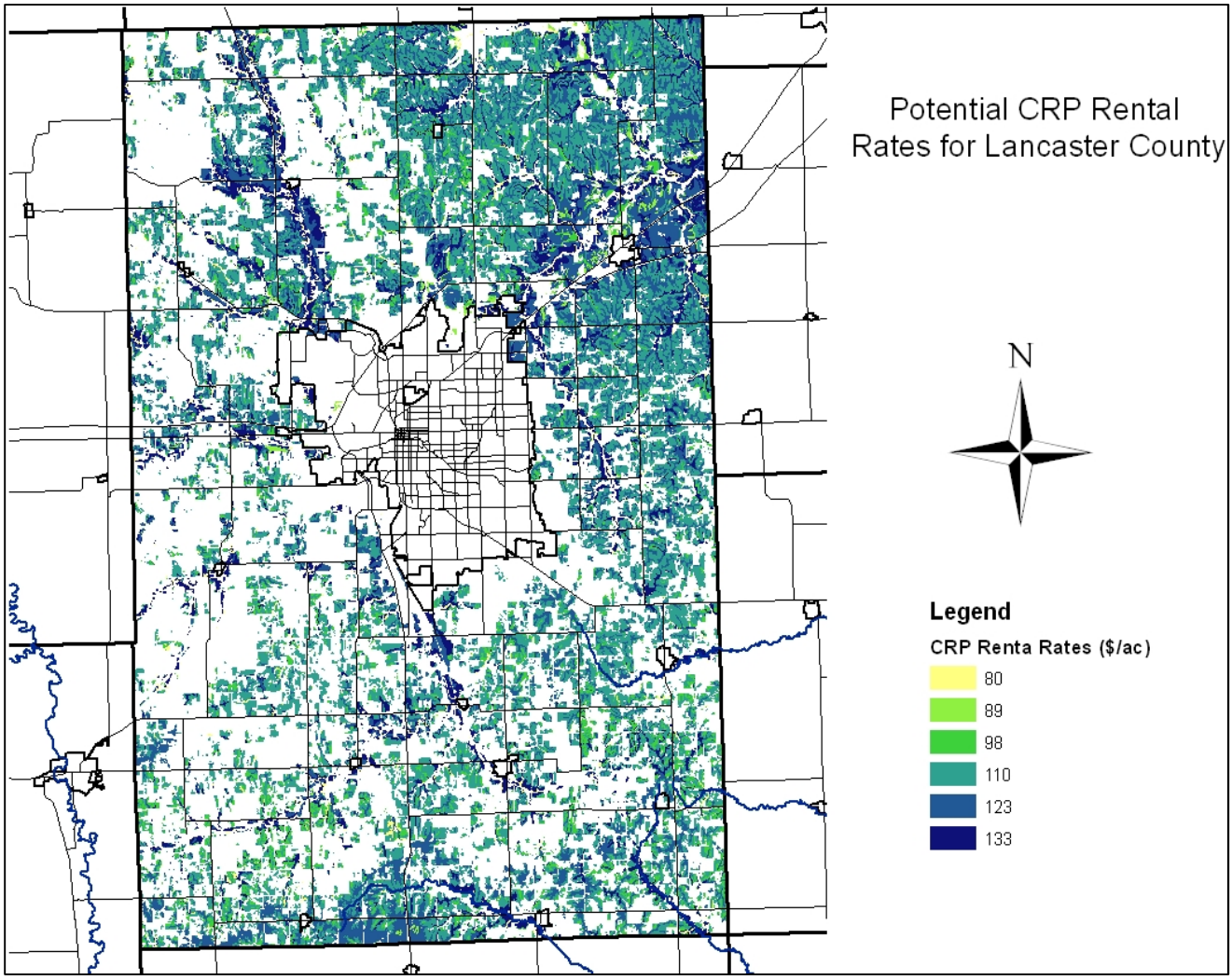

Figure 5: the rental rates offered by for CRP based on the EI derived from the soil series for cropland within Lancaster County.

CRP Profitability:

Current profits for commodity prices with corn at $5.97 and soybeans at $12.75 make CRP not economically feasible at this time (Fig 6). The least viable option is removing irrigated corn from production with profits per acre reaching over $500 while CRP is averaging only $105.50. Placing dryland corn in CRP would result in the smallest economic loss for a landowner. However, it is still a $159.24/acre loss.

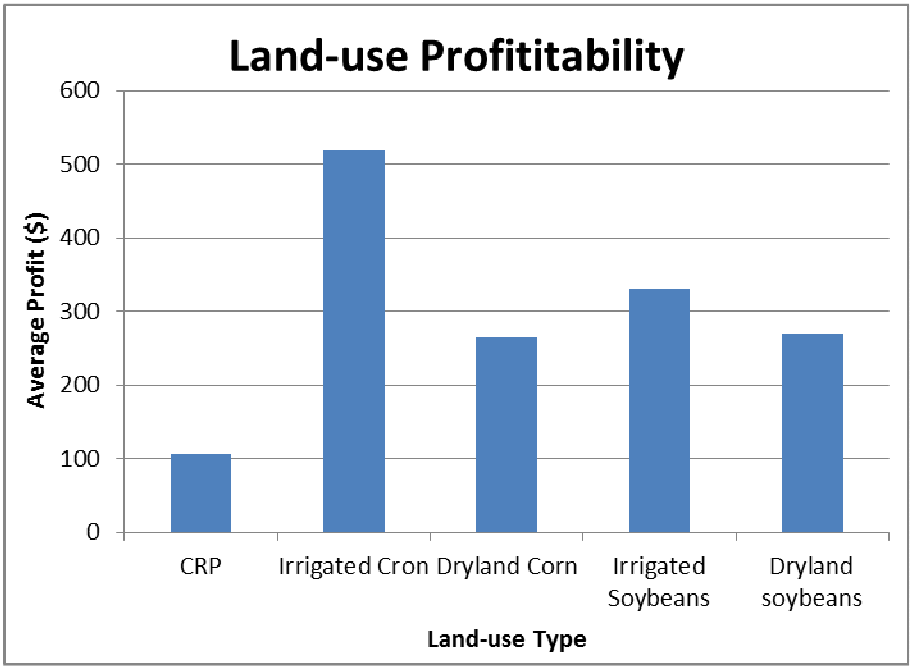

Figure 6: CRP profitability per acre compared to the profitability of the 4 main farming practices in Lancaster County at March and

Knowing that current commodity prices make CRP a poor economic choice provokes the question at what point does CRP become economically viable? Figures 7-10 graph the point that commodity prices need to be at for CRP to be equally profitable to farming. To do this 2005 and 2011 prices were used to determine yields and a line was drawn between the two. These graphs reflect current average yields and current average input costs for both years. At 2005 prices the net incomes for soybeans and corn under irrigated and rainfed are negative. Where the line crosses 0, indicating $0 profit difference, determines the commodity price that marks the

transition between CRP profitability and CRP loss. Due the large area that dryland agriculture covers it is especially of interest for Lancaster County.

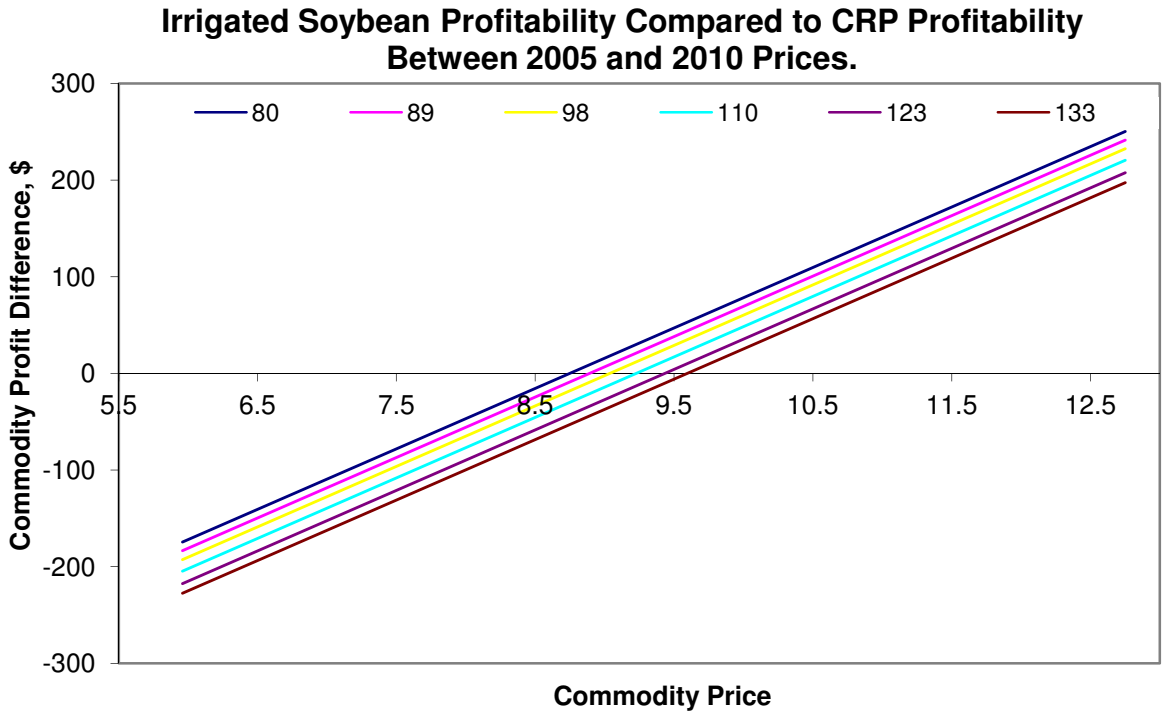

Figure 7: Price soybeans must be at for CRP, at each rental rate, to be viable under irrigated conditions.

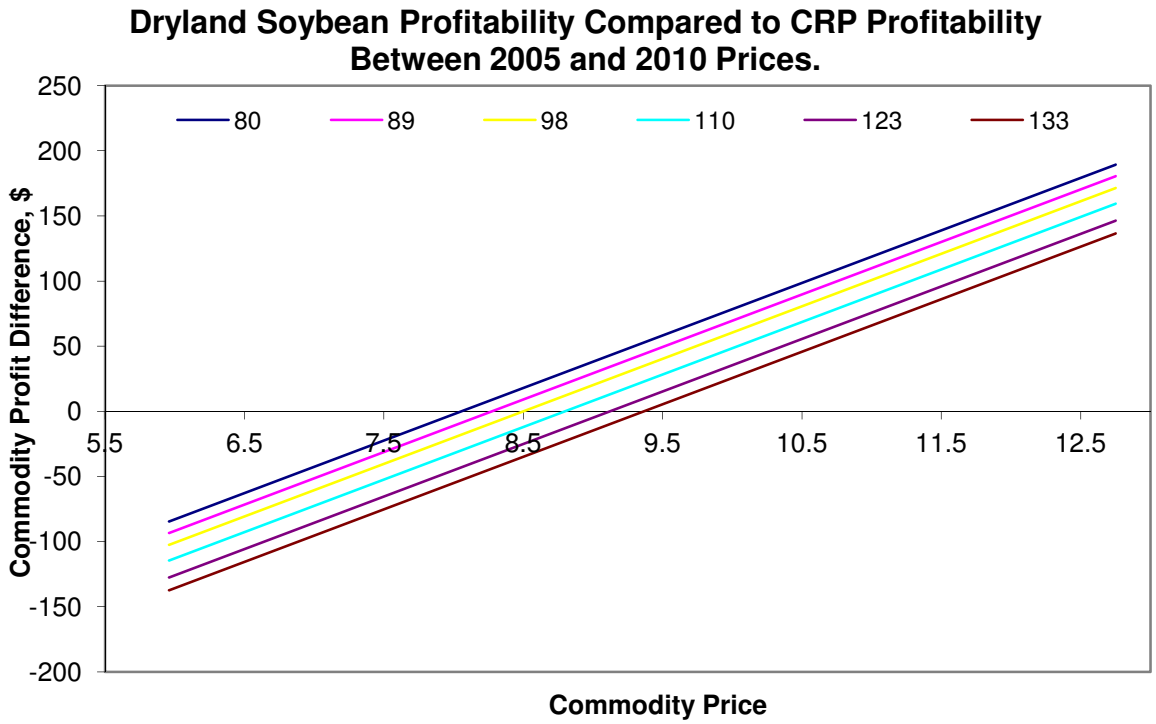

Figure 8: Price soybeans must be at for CRP, at each rental rate, to be viable under dryland conditions.

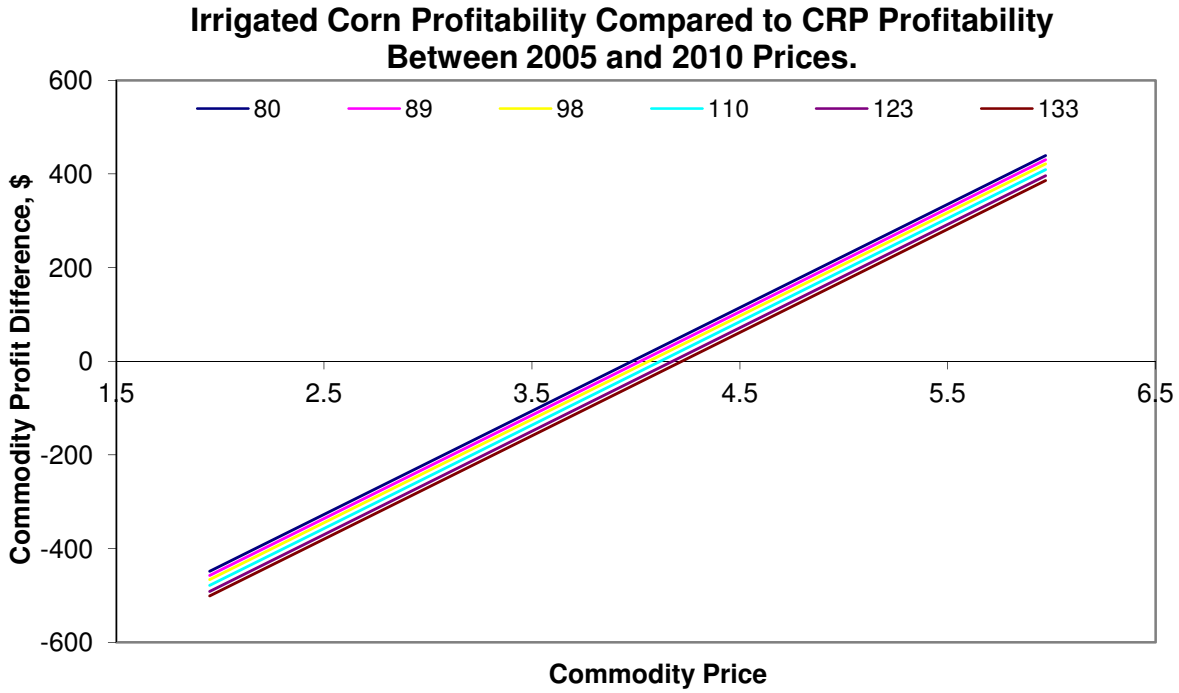

Figure 9: Price corn must be at for CRP, at each rental rate, to be viable under irrigated conditions.

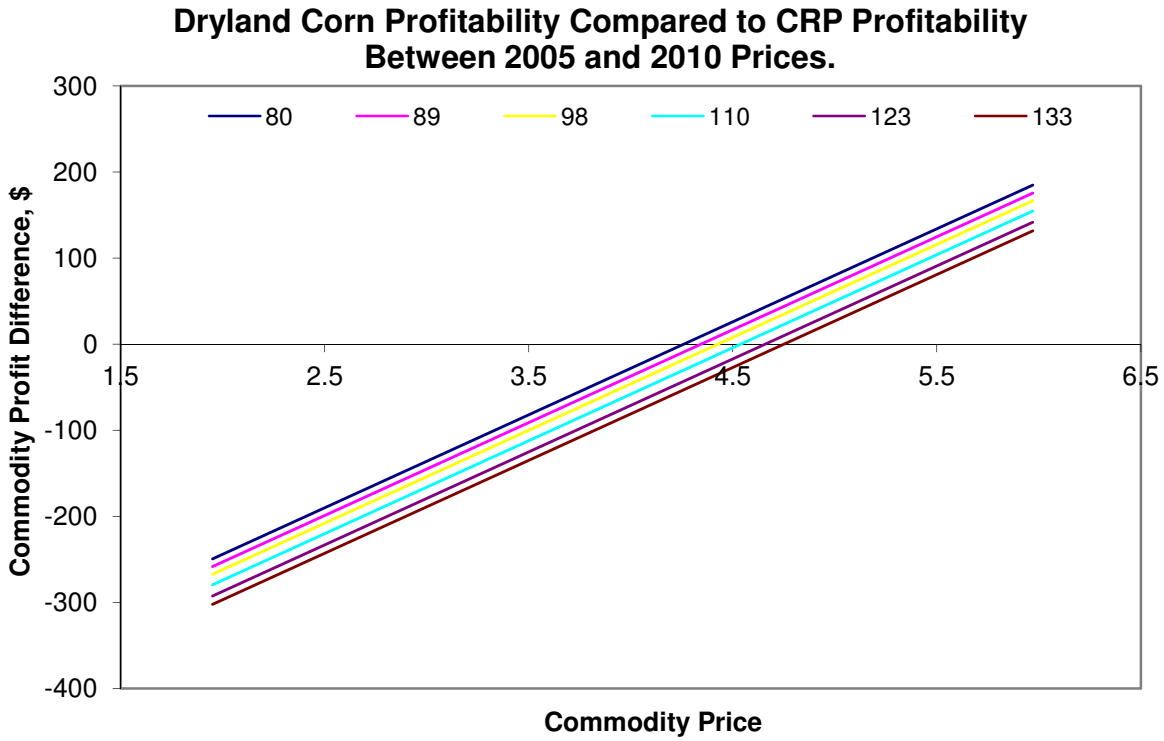

Figure 10: Price corn must be at for CRP, at each rental rate, to be viable under dryland conditions.

These results enhance the body of literature on CRP mapping by combining the land classification techniques and the SSURGO data which includes the erosion potential. Much of the available literature focuses on mapping already assigned CRP land without addressing the potential CRP areas. This study also offers an economic evaluation of the profitability of CRP at current commodity prices and at what price commodities must be at for CRP to be the most economic viable option for land owners.

Summary and Conclusion

One solution to reduce the ever growing erosion rates on agriculture land is to allow the land to lay idle and let a natural cover grow. The Conservation Reserve Program gives land owners an incentive to do just that. This study is designed to give farmers a reference to see; 1) if their land is eligible for CRP based on requirements designated by the FSA and 2) how much the CRP contract would pay based on the soil types found in that area. Also, it was found that at current soybean and corn prices it is not profitable for landowners to place their land that is in production into CRP. The study shows the price soybeans and corn under dryland and irrigated conditions would have to be set at for the land owner to achieve the highest income. Although CRP is not a practical option at current commodity prices, it has long term benefits. By allowing the soil to regenerate ensures that the soil remains highly productive for years to come. Also,

CRP land reduces soil erosion effects on the larger scale. By reducing erosion levels there will be less sedimentation in unwanted areas such as downstream reservoirs.

The results of this project can assist in many decisions that land owners and even the FSA have to make. The landowners in Lancaster County now have a quick, easy guide to refer to, to see if their land is CRP eligible. This project can also be of use for the FSA when deciding who should have priority when being considered for CRP enrollment. The maps give FSA the opportunity to spatially distribute CRP acres across watersheds for optimum benefits throughout the county.

To continue this study it would be useful to apply this model to all the counties within Nebraska so that each farmer has a simple way to determine whether their land meets all the CRP requirements. Each county will have different soil erosion rates and different amounts of irrigated and rainfed agriculture land resulting in different potential profitability for land owners. Another continuation of this project could be to analyze the distribution of CRP lands already in existence to develop a spatial model of watersheds that are lacking erosion control. The areas that have a low amount of CRP acres could then be the target regions for new CRP enrollment. To improve the quality of the research the use of multi-temporal land cover should be used to increase the accuracy of the land cover classification (Egbert 1998). However, this option is more expensive and less accessible than the single-date Landsat imagery.

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