The Science and Policy of Sustainability:

An Exploration of the Conservation Stewardship Program and its Role in Montana Agriculture

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Department of Land Resources and Environmental Sciences - Capstone Class 2011

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Policy

The infamous Dust Bowl of the 1930's was one of the most significant events in the history of American agriculture. Not only was it a representation of the arduous times that the nation as a whole was going through, but it was also the product of extreme drought, decades of extensive farming without crop rotation, fallow fields, cover crops or other techniques employed to resist soil erosion. As a result of these tumultuous times, Congress was pressed into passing legislation to assist the farmers (Schuler, 2011).

For the past 75 years, ever since the New Deal programs of the Roosevelt administration, federal policy makers have taken an active role in agriculture. Every five to seven years, agricultural policies are evaluated and reauthorized through the federal Farm Bill (IATP, 2007). Each bill is given its own formal name (e.g. Farm Security and Rural Investment Act of 2002), but generally it is simply referred to as "the Farm Bill". Throughout the years, the bill has grown to be one of the most, if not the single most, significant legislative measures affecting land-use policies in the United States (Imhoff, 2007).

While many people parallel its programs and subsidies with provided assistance for struggling farms, there are actually two predominant pillars for its structure: (1) Food stamps and nutrition programs; and (2) price supports and income for various storable commodity crops (Farm Policy Facts).

There are also programs that fund other components of federal branches, such as forestry, conservation and environment, renewable energy, research, and rural development (Imhoff, 2007). The rationale for employing these programs and subsidies via the Farm Bill are: to support "family" farmers who used to be less well off than urban residents; to create a secure and dependable source of food; to offset the price and production (weather) risk faced by farmers; and to maintain rural areas (Young, 2011).

The Farm Bill came about to provide equity and stability to the farmers of the United States. Effectively, the farm programs were designed so that farmers could be sustained given the highly cyclical nature of agriculture. The last bill was passed in 2007; the next one is expected in 2012. The larger public is discovering that policies in the Farm Bill affect not just the farmers in the agriculture sector, but also the rural communities, the environment, health, hunger, immigration, world trade, and global food prices (IATP, 2007). The importance of this Farm Bill, as well as all of the past and future bills, cannot be emphasized enough.

The ramifications of Farm Bill policy reach many corners of society and agriculture. Farmers are provided with a safety net from which they can derive their practices without having to face the risks of factors that they cannot control (i.e. weather patterns, global prices). By supporting the farmer's income, they can then focus on producing a crop that will have far reaching benefits to society on the local, national, and global scale. Certain subsidies impact the farmer's decision making, in particular conservation programs that reward farmers for changes in their production practices (Young, 2011). All of these subsidies can have environmental impacts on the farms, including those on soils, water quality, and wildlife.

The subsidies that go to support the farmer are divided into three different payment forms. The direct payment, which originated in the 1990's and was originally called a market loss assistant, is defined by the market providing the return needed to pay for the production of the crop. The counter cyclical payment is provided when the average price of grain costs drops below a certain level, resulting in a price support mechanism. This mechanism is triggered to support the farmers in the time of financial strain. (*Note-the minimum price is so low that it has never been triggered.) The final form of subsidy is the marketing loan assistance program. If the price for a crop gets too low, the farmer can put their grain up as collateral for government-funded loan. If the price and market for grains continues to drop, the farmer can then simply forfeit their grains to the government (Schuler, 2011).

The government's subsidies and intervention into the free-market proves to be beneficial for the farmers, the agriculture sector, and society because it promotes environmentally conscious practices. Without the government's action, it is likely that the market will produce goods, like corn, that yield immediate financial benefits to the producers. However these profits undervalue the goods and services provided by the ecosystem and its functions, often depreciating the intrinsic value of the land and its resources. The farmer is a profit maximizer and society has not regularly paid for services provided by the agricultural ecosystem, therefore diminishing the likelihood of implementing conservation savvy practices (Young, 2011). Ecological system services and their natural capital stocks are critical to the functions of the Earth's life-support system. These services contribute both indirectly and directly to human welfare and as result make up part of the total economic value of the planet (Costanza, 1997).

Congress under the 2002 Farm Bill established the Conservation Security Program. The Conservation Security Program was a voluntary conservation program that rewarded farmers who used conservation practices on their farmland by using pay for practice incentives (Keeney and Kemp, 2003). Those who signed up for Conservation Security Program were financially rewarded for practicing resource-conserving farming and ranching strategies. These stewardship incentives allowed the individual farmer to protect the environment while also creating an economically viable, income-producing farm (National Wildlife Federation, 2007). Through the Conservation Security Program, environmental issues such as surface water quality, fish and wildlife habitat, soil and air quality and conservation were addressed and changed by implementing specific agricultural practices. These practices included diversified crop-rotation systems, no-till, cover cropping, conservation grazing, windbreak buffers and other resource conserving strategies (Keeney and Kemp, 2003). Farmers who practiced sustainable land use over the long term received the highest rewards in the Conservation Security Program (National Wildlife Federation, 2007).

The Conservation Security Program was administered by the Natural Resource Conservation Service (NRCS) and was funded through the Commodity Credit Corporation (Cowan, 2008). The Conservation Security Program was set up to work on conservation issues in selected watersheds, therefore, not everyone could sign up and receive payments. Financial incentives were based on three tiers, with the third tier representing higher conservation and resource conserving standards, and contracts were offered from 5 to 10 years (Dellwa, 2011). The tiered approach allowed farmers who had higher levels of environmental management to receive higher payments. For instance, Tier I meant the producer addressed soil quality and water quality to a minimum level of treatment. Tier 1 contracts lasted for only 5 years and paid a maximum of $20,000 per year. Tier II meant that the producer addressed soil quality and water quality to a minimum level of treatment *before* acceptance into the Conservation Security Program and that one additional resource must be addressed and improved by the end of the contract period. These Tier II contracts lasted for 5 to 10 years and had a maximum cap at $35,000 annually. The highest tier, Tier III, meant that the producer addressed all resource concerns for their management system and met them at a level that met the NRCS standards. These contracts lasted 5 to 10 years and had a maximum cap at $45,000 per year (Department of Agriculture, 2008). With the Conservation Security Program available to farmers and ranchers, producers had a way to change their land use practices to conserve environmental resources in an economically viable way. Though this was one large step towards better land and resource management, there were a few problems with the Conservation Security Program. First, the program wasn't available to anyone in the country; it was only available to those in certain watersheds (Dellwa, 2011). The lengthy process of signing up for the program and determining payments via the tiered approach also made registration difficult and complicated.

The 2008 Farm Bill made improvements and strengthened the Conservation Security Program. Its name was changed to the Conservation Stewardship Program (CSP) and it was expanded to help all farmers and ranchers across the country establish and increase conservation on land they were actively farming (Dellwa, 2011). This new program provides $12 billion over 10 years to enroll about 13 million acres a year (Department of Agriculture, 2008). Its major changes included non-exclusive signup. This allowed anyone who met the minimum requirements to sign up for CSP payments. It became available for all working agricultural land including cropland, grassland, prairie land, improved pastureland, rangeland, non-industrial private forestlands and agricultural land under the jurisdiction of an Indian Tribe (Department of Agriculture, 2008). All contracts last only 5 years and there is a $200,000 total cap. There are no more tiered levels. Payment levels are now made by using the Conservation Measurement Tool (CMT) (Dellwa, 2011). The CMT calculates a score by asking producers about farming practices, techniques and willingness to take on additional conservation activities (Cowa, 2008). Certain "priority resource concerns" such as soil erosion, water quality, soil quality, water quantity, air quality, energy, wildlife and biodiversity are given importance. Each state selects three to five of these priority resource concerns. For a farmer to receive a contract, they must meet or exceed the stewardship threshold for at least one priority resource concern and be willing to do the same for one additional priority resource concern by the time the contract has ended (Department of Agriculture, 2008).

The CSP plays an integral role in the sustainability of farmland practices. The highly connected nature of agriculture with its biotic and abiotic components emphasizes the high level of consideration that must be taken when farmers employ their practices for grain production. Since the market undervalues conservation practices, the CSP ensures that financial incentives are provided to agronomists who produce grains for their local communities, their country, and the global population.

Currently, the CSP is threatened to receive drastic financial changes. When the CSP was enacted, Congress placed a ten-year funding cap on the program. With the 2012 Farm Bill currently being written under a economically and fiscally tough time, funding for conservation efforts will likely be slashed. Some suggest allocating the money used for commodity price support payments and subsidies and put it towards programs like the CSP. However, on November 15, 2011, House and Senate negotiators reached a compromise deal on a fiscal year 2012 appropriations bill (H.R. 2112) that includes the agriculture appropriations bill. The FY 2012 bill cuts more than $927 million from farm bill mandatory conservation. Conservation and renewable energy were the primary farm bill mandatory programs cut and crop insurance and export and commodity subsidies were left relatively unscathed. The CSP received a large cut in its spending, totaling $75.5 million, roughly 9% relative to its FY 2012 farm bill-mandated level. This large cut may reduce the size of the 2012 CSP sign-up by more than 30% (Wasson, 2011). There is currently a lack of bi-partisan agreement on how money should be spent and what should be cut for the 2012 Farm Bill.

The CSP is a successful tool when it comes to changing and increasing the sustainability of our agricultural systems, however, it is not ideal. With its financial challenges ahead, it's risky to rely on CSP as the only answer to a future of sustainable agriculture. Currently, aspects of CSP change every year, making the program unpredictable for farmers, and some feel like the difficulty and volume of the paperwork necessary for the sign-up is not worth it. Perhaps if stronger priorities were set and the CSP was made more 'user friendly', more will sign up. There are other ways as well to encourage farmers to use these resource-conserving practices that don't rely heavily on policy. Successful research and outreach of new knowledge can influence farmer decision-making. It will take diverse solutions to reshape the future of agriculture into something more sustainable.

CSP in Montana

Of the 42 states producing wheat in the United States, Montana is ranked fifth in overall wheat production. 45% of the wheat grown in Montana is produced within the Golden Triangle: an imaginary triangle outlined by Shelby, Great Falls, and Havre (MWBC, 2006). Six million acres of wheat are planted annually in the whole of Montana, producing a statewide crop worth over one billion dollars

(McVay et al., 2010). A majority of the wheat is produced by dryland agriculture: non-irrigated agriculture in semiarid/sub-humid climate regimes. Successful dryland agriculture necessitates soils capable of storing moisture, specially adapted crops that are able to endure the climatic extremes, and innovative farmers that can adapt a management system to fit their local environment (Granatstein, 1992). The wheat crop of Montana consists of 3 major types. Of the 6 million acres planted in Montana, 56% of that area consists of spring wheat, 33% winter wheat, and the remaining is planted for durum wheat. Spring wheat and durum are planted early in the spring and harvested in late summer. Winter wheat is planted in the early fall, remains dormant over the winter, and is harvested in the summer. Average yields for spring wheat are 25 bushels/acre; typical yields for winter wheat are 36 bushels/acre. Prices in 2010 for spring wheat were $6.25 per bushel, and for winter wheat were $5.55 a bushel (USDA, 2011). Generally speaking, winter wheat will provide higher yields over spring wheat, especially when adequate amounts of soil moisture are present for production (McVay et al., 2010). Winter wheat develops a deeper rooting system than the spring varieties; thus it is able to obtain more moisture from the soil profile. Due to its superior moisture collection, winter wheat is preferred over spring wheat after a summer fallow: in which the ground is left bare for the summer, saving two seasons of water for a single wheat crop (McVay et al., 2010).

The climate of the Golden Triangle is characterized by extremes in both temperature and precipitation. At Great Falls International airport, average temperatures in the winter can range between 1.7˚C and -11.4˚C (NOAA, 2002). Low winter temperatures can be problematic when growing winter wheat. By winter, the plant has sprouted several inches above the soil's surface and its growth can be impaired by temperatures below -20˚C. To bypass the potential for crop damage by winter's extremes, many farmers in northern Montana will grow durum or spring wheat instead of the winter variety (McVay et al., 2010). Great Falls receives an average of 37.8 centimeters of precipitation annually (NOAA, 2002). Optimum wheat yields are obtained with 45-65 centimeters of plant available water (FAO, 2011). Most often in a dryland wheat production system, water availability is the largest contributor to yield fluctuation.

In a traditional dryland production system, wheat is cultivated in a tilled wheat-fallow cropping system: wheat is sown in the spring or winter (depending on the variety), the stubble tilled into the topsoil, and the field left to fallow for the rest of the season until the next wheat crop is ready to plant. The stubble is tilled into the topsoil to create an even seed bed and increase its decomposition. Fallow is often used in dryland production systems to increase the amount of soil water available for the next crop (Sainju et al., 2010). During the last 50-100 years, both organic carbon and nitrogen content in soils have decreased to 30-50% of their original levels (Sainju et al., 2006). These traditional methods of wheat production are unsustainable in practice because of the resulting degradation of soil quality. When a field is left to fallow, the bare soil will absorb more solar radiation. This warmer temperature, coupled with increased soil moisture, intensifies microbial activity, accelerating the mineralization of nitrogen and soil organic matter. The increased amount of nitrogen, provided by the microbial degradation, can be lost through immobilization by weeds, or leaching into groundwater. To decrease weed growth when in fallow, herbicides must be applied to the field. This is also necessary to minimize water losses due to weed growth. The increased degradation of soil organic matter is problematic to soil health because the organic matter in soil plays a vital role in nutrient exchange, water retention, soil aggregation, and contaminant immobilization (Sainju et al., 2006).

When growing wheat, nutrients must be closely managed to produce the highest economic yield possible. On a pounds/bushel basis, a wheat crop harvested exclusively for grain will remove 1.25 pounds of nitrogen, 0.62 pounds of phosphorus (P_2O_5), and 0.38 pounds of potash (K_2O). Agricultural production will also remove a variety of micronutrients; they are usually required in such small amounts that their content in soil is rarely managed. If wheat straw was to be harvested, in addition to the grain, 14.5 pounds of nitrogen, 3.6 pounds of phosphorus (P_2O_5), and 25.0 pounds of potash (K_2O) would be removed from the soil (McVay et al., 2010).

To alleviate the high inputs of traditional wheat production, some farmers have turned to organic agriculture. In relation to soil fertility, organic agriculture attempts to maximize the use of on-site resources such as manure, composts, legumes, and green manures to replace synthetic fertilizers as sources of nutrient inputs (Sullivan, 2003). As of 2008, 40,000 acres in Montana are used to grow wheat organically (USDA ARS, 2010). This makes up 0.7% of the total wheat production acreage for the state. Organic producers can receive $1-2 more per bushel for their wheat, depending on market fluctuations (Sullivan, 2003).

Land use has been a major factor in agricultural legislation since the first Food and Agriculture Act of 1977 (Imhoff, 2007). Today, conservation of farmland is of concern, particularly soil conservation practices. Soil quality refers to the ability of soils to perform specific ecological functions, including sustained biological activity and diversity, water storage, filtering/buffering to change, and nutrient storage and cycling (Seybold, 1999). The rate of soil loss is much greater than that of soil formation (Fig. 1), simply due to the time it takes for soil to develop compared to the impacts agriculture has on the land.

In a comparison by Montgomery (2007) the rate of soil erosion by means of conventional agriculture is 1-2 orders of magnitude higher that that of conservation agriculture soil production, soils with native vegetation and the rate of geologic erosion. Conservation agriculture utilizes practices that conserve soil quantity and quality. It considers the degree to which soil is resilient to distress (Seybold, 1999). The greater the soil quality, as defined above, the more resilient to disturbance it is; that is it can bounce back from a distressed state. Approximately five percent of the world practices conservation agriculture (Montgomery, 2007). The existing native topsoil is quickly being lost and we are reaching a point when we need to make changes in techniques, or will have increasingly less area for agriculture.

Soil fertility as a function of agriculture practices is dependent on site conditions such as organic matter and nutrient content and soil texture and structure (Montgomery, 2007). Operations revolving around seasonal tillage regimes are likely to see a development of a plough pan or hardpan within a few years. In addition to decreasing root penetration by plants, one may be required to break up a plough pan before cultivation, which can lead to more rapid degradation of machinery (Shamsabadi, 2008). Numerous plowing techniques have varying effects on the soil. Disc plow uses a rotating disk to break up and turn over soil.

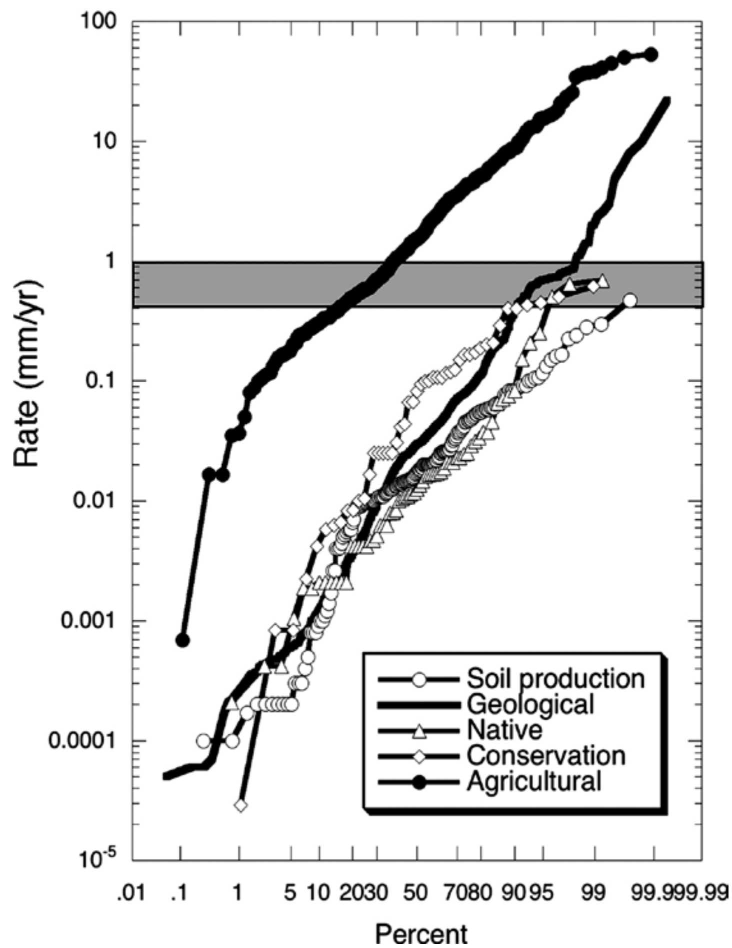

Figure 1. Probability plots of rates of soil erosion from agricultural fields under conventional (e.g., tillage) and conservation agriculture (e.g., terracing and no-till methods), with erosion rates from areas and plots under native vegetation, rates of soil production, and geologic rates of erosion (a composite distribution of the data for cratons, soil-mantled landscapes, and alpine areas in Fig. 1). Shaded area represents range of USDA. T values (0.4–1.0 mm/yr) were used to define tolerable soil loss. (Montgomery, 2007)

The main function of a chisel plow is to break up soil while leaving crop residue on top. It can be used to help break up a plough pan. Since the chisel plow does not turn over soil, exposing it to erosion by wind and water, it has become a preferred method in low till farming operations (Schaefe, 1996). For areas which receive between 300-500 mm of precipitation a year, the chisel plow was the recommended technique for preparing a seed bed and preserving soil structure, maintaining high moisture content and organic matter and reducing erosion (Shamsabadi, 2008). A moldboard plow works by turning over the top few inches of soil almost completely. This practice has lost favor over time due to the extreme vulnerability of soil to wind and water erosion by exposing the subsurface.

Contour tilling and inter-cropping promote soil conservation. Slopes are hazards to soil loss because they act as a highway for water to carry away sediments (A. Sigler, personal communication, 2010). Tilling on the contour reduces slope length by creating buffers of vegetation perpendicular to flow paths, to catch water and sediments. Inter-cropping reduces the area of soil that is exposed to water and wind erosion (A. Sigler, personal communication, 2010). Alternating rows of cereals and legumes enhances soil structure and increases water storage by reducing evapotranspiration and contributing organic matter. Crop rotations can enhance soil structure by alternating shallow rooting crops with deep rooting crops. Deep rooting legumes such as alfalfa can aid in breaking up otherwise compacted soil, increasing water infiltration, and replenishing nitrogen when used as a green manure.

The movement of free water is dependent on matric forces and energy gradients (Wuest, 2011). A lack of soil structure can contribute to low water holding capacity due to lack of infiltration. The use of pulse crops can increase the quality of the soil by protecting id from degradation. An increase in soil stability and a decrease in soil compaction were seen in a pulse crop system compared to a system that utilized fallow in rotation (Ganeshamurthy, 2009). In addition, total nitrogen and available water increases slightly in a pulse crop system compared to a low till system (Miller, 2001). Stored water is critical to growing crops such as spring wheat and barely in semi-arid regions (Aase and Schaefer, 1996). Though inferences to soil water content are complex, direct observations can be made on soil structure. Reduced tilling decreases soil compaction allowing roots to penetrate deeper into the soil profile encouraging development of soil structure conducive to greater water holding capacity and greater nutrient uptake by crops (Shamsabadi, 2008). Decreased loss of soil and nutrients by erosion and leaching will increase water quality and decrease overall cost of inputs and soil maintenance. Enhanced efficiency fertilizers are a method of reducing nutrient loss.

Nitrogen use efficiency (NUE) is the grain production per unit of N (nitrogen) available in the soil. It is calculated as grain weight divided by N supplied (Thomason et al., 2002). NUE can be improved upon in two ways covered by CSP: enhanced efficiency fertilizers and timing of application. Increasing NUE will give farmers a better economic return and protect the environment from nitrogen leaching and volatilization. Global food production has doubled since the middle of the 1960s, and the use of nitrogen fertilizers has increased of 700%. Many would think that cultivated land has increased in a large amount as well, but it has only increased by 110%. This shows that farmers are becoming more dependent on external resources and the best way to reverse this trend is through more efficient use of fertilizers.

Enhanced efficiency fertilizers (EEFs) can be either controlled release fertilizers, or nitrification and urease inhibitors. Controlled release fertilizers have a polyurethane coating that protects the fertilizer within. The coating allows moisture in to dissolve the fertilizer granule, but contains it instead of releasing it all at once. Temperature drives the release process and slowly allows the liquefied fertilizer to seep out. This process allows plants to receive nutrients over a period of time instead of having them delivered all at once.

Nitrification inhibitors constrain the oxidation of ammonium to nitrate, slowing down the natural nitrogen cycle that occurs in the soil. Nitrate is then available to plants for an extended period of time, up to two weeks. Urease inhibitors are coated on urea fertilizer (46-0-0 NPK) to decrease nitrogen volatilization, the release of nitrogen to the atmosphere. The decrease of volatilization happens by slowing the conversion process of urea fertilizer to ammonium, keeping nitrogen in the soil.

The first step to improve NUE is to refine the rates of fertilization (Nelson et al., 2008). This can be accomplished through both timing of fertilization and EEFs. One of the main concerns with using EEFs, especially in Montana, is whether the environmental conditions are appropriate. One example is that success of volatilization control products (urease inhibitors) is dependent on the temperature and moisture conditions following fertilization. If the conditions are not right, the use of a urease inhibitor can reduce NUE when urea is broadcast. It has also been noted that when urea by itself is placed with seedlings at planting, there was a stand loss and reduced yield compared to that of a polymer-coated urea (slow-release fertilizer) that showed no effect on seed germination when placed with the seed at planting. This is most likely due to the fact that the urea released too much N and overwhelmed the seedling, killing it or impeding its growth.

Altering fertilizer application timing is another tool for increasing NUE instead of applying fertilizers all at the time of planting. Farmers can repeat applications throughout the growing season as the plant needs them. Application of fertilizer in a timely manner decreases the amount of nitrogen molecules lost from the system through leaching or volatilization, and can result in an increased NUE. In Montana, split application is most effective when applied in the liquid form, and even then, more on irrigated farm ground. Even with the application through liquid, water is still needed to make the nitrogen available to the roots for uptake. Another benefit to split application is in dry years, when moisture is a limiting factor. Fertilizer may not help wheat produce a better yield, so farmers may choose not to apply as much fertilizer as in previous years. This will help out the farmer economically as well as the environment with a decrease in nitrogen leaching.

The idea of using EEFs is to increase short-term fertilizer nutrient recovery by crops (Fixen, 2009). With the increase in fertilizer prices in recent years and the time value of money, a short-term nutrient recovery is needed. There is also a need to decrease the movement of nitrogen from areas of crop production to areas outside the agroecosystem. Ideally, farmers want to keep nitrogen molecules within the agroecosystem's cycle. This will, in turn, increase NUE. With an increase in short and long term NUE, there will also be protection of water quality. To ensure the highest efficiency, there needs to be synchronization among plant demand and nitrogen supply. This depends on seasonal weather and changes in cropping systems. Many EEFs are not used by growers because they are not always cost effective for their system or do not fit into their total farm management system. This is where split application of fertilizer may be more effective to the grower.

Some of the CSP practices can drastically reduce the amount of sediment and phosphorus lost in an agricultural field to a water body. When soil is lost from the field, it can be transported into water bodies by both wind and water erosion, in turn leading to negative effects on the aquatic systems through the covering of coarse substrates, deposition in pools, and increased turbidity that can interfere with the growth and reproduction of fish and other aquatic life (IDNR, 2000; Schilling, 2001; Cournane, 2011). Phosphorus is delivered via overland flow into receiving water resources, usually attached to soil particles. Since loss of sediment and phosphorus in an agricultural field is commonly a result of either wind erosion or water erosion, if you slow down or even stop the amount of erosion that will take place, you will slow the amount of sediment and nutrients that enter the water body (Min-Kyeong, 2011).This can lead to an increase in eutrophication, which results in depleted oxygen supply that can harm aquatic life and surface wildlife.

Practices that reduce the amount of sediment and phosphorus entering the system include minimal till or no till systems, in which the crops are left in the ground and seeds are interpolated with the old crops so that the soil is not overturned every year. Through the use of minimal till, the soil structure is built up, increasing surface roughness and above ground obstructions, as well as leading to an increase of organic matter which will lead to a decrease in erosion which will slow down the movement of water with more obstacles for the water to overcome and will allow for the sediment and phosphorus to be retained in the field. In a study performed by Williams (2010) from 2000 to 2006 in northeast Oregon on upland wheat, surface runoff and sediment yield from conventional and no till cropping systems in the headwaters of an agricultural watershed was measured. Williams used the Water Erosion Prediction Model (WEPP) to calculate runoff of the agricultural areas. WEPP is a process based model that simulates water erosion by coupling hydrology, hydraulics, erosion mechanics, and plant science (Williams, 2010). Physically based soil erosion models quan-tify infiltration, runoff, and erosion through soil water dynamics and vegetative growth. Therefore, model assessments include comparisons of simulated and observed runoff and erosion, as well as evaluation of simulated crop growth (Williams, 2010). The study determined that through the use of no- till farming when compared to tillage or conventional farming, the amount of runoff that occurred each year in the studied watershed was significantly less as a result of the conservation practice.

One way to reduce sediment and nutrients entering the water body is to add an edge-of-field buffer strip to catch the sediment. Vegetation buffers are strips of land with permanent vegetation designed to intercept storm water runoff and minimize soil erosion. Soil particles accumulating as sediment in a lake can suffocate organisms and reduce sunlight needed by aquatic life (DNR, 2011). Planted buffer strips result in an up to 57% reduction in sediment loss as well as a 50% reduction in sediment loads into rivers and streams and up to a 39% reduction in phosphorus loss, both attached and soluble (NRCS, 2011). However, buffer strips can only have a significant impact on reducing the amount of sediment and phosphorus that enters the water body if they are place next to the stream, river, or lake. Buffer strips in the middle of the agricultural field do not have as great of a reduction in sediment loss or phosphorus loss.

Cover crops can also reduce sediment and phosphorus loads into the water body. When used properly, cover crops protect the soil from erosion during the winter months, take up nutrients remaining in the soil, and release plant available nutrients slowly over the subsequent cropping period, thereby reducing nutrient leaching and runoff during the non-growing season (NRCS, 2011). Living mulches are cover crops planted either before or with a main crop and maintained as a living ground cover throughout the growing season (Hartwig and Ammon, 2002). Living mulches are often perennial species and are maintained from year to year. Ideally, the growth of the living mulch is suppressed when the main crop is growing, and increases as the main crop matures or when it is no longer present (Kaspar et al., 2008).

Funding CSP Projects

CSP-funded enhancements can greatly improve the water quality of nearby agricultural streams by reducing nutrient leaching in groundwater and surface water runoff. Being able to control erosion and increase the soil structure is key for the reduction of surface runoff, and can drastically reduce the amount of phosphorus and sediment that enters a water body. All the practices under the CSP can improve water quality, but it is ultimately up to the producer to implement these practices. In 2008, Congress approved $12 billion for approximately 13 million acres a year through 2018. Funds are allocated per state according to their share of agricultural acreage.

There is no fixed filing date for CSP, but at certain times of the year NRCS will take all farm proposals that have been turned in to date and rank them according to current and proposed conservation practices. A farms rank is determined by a conservation assessment using the Conservation Measurement Tool (CMT). An applicant's performance is based off of four ranking criteria put foreword by the NRCS:

> "1. The level of conservation treatment on all applicable priority resource concerns at the time of application.
> 2. The degree to which the proposed conservation treatment on applicable priority resource concerns increases conservation performance.

3. The number of priority resource concerns proposed to be treated to meet or exceed stewardship thresholds by the end of the contract.

4. The extent to which other resource concerns, in addition to priority resource concerns, will be addressed to meet or exceed stewardship thresholds by the end of the contract." (NRCS. July 19, 2010**)**

CMT applies a point system according to priority resource concerns for each one of the four criteria, which are multiplied by a weighting factor and 0.25. The final score to determine an applications rank is the sum of the four ranking criteria. However special weight is given to three to five of eight priority resource concerns as determined by each state or NRCS sub-region. Currently these eight priority concerns are soil erosion concerns, soil quality functions, water quality concerns, air quality, plants (biodiversity), animal concerns (wildlife), water quantity concerns, and energy concerns. For an application to be eligible to receive a contract, one priority concern must meet or exceed a selected priority concern prior to the contract and another priority concern must be prior to the termination of the contract period.

CMT allows applicants to also pick up Enhancement Activities and conservation practices to increase their score. Existing and additional activities and practices are scored points from -5 to +5 points for the eight priority resource concerns for each land use. For determination the points of the exiting activity points and additional activity points are divided potential existing activity points per land use per priority resource concern multiplied by 100 before being compared to a stewardship threshold value for each land use for each resource concern for the application.

However, the CMT points are not just for determining acceptance into the program, but also comprise the payout structure. Payout is determined on point value by the CMT, cost incurred for implementing conservation activities, and income foregone for said activities. The expected overall average CSP payout is $18 per acre, but individual payouts vary exceedingly. CSP payouts are capped to

$200,000 per applicant over the period of the five-year contract. The by-point payout will change annually due to the change of potential performance points to additional and existing points as enhancements are met per land use, as detailed in the point considerations above. Since existing points and additional points are compared against potential points, there is an incentive to convert potential points to existing points early in the contract to maximize final payout. Also, payout structures are split between existing activity payment rates and additional activity payment rates annually. Supplemental payments are made to CSP participants that opt to adopt 'resource-conserving crop rotation.' The annual supplemental payment rate is determined by an NRCS specialist that compares the difference between the annual crop productions cost for conventional and the adopted resource-conserving crop rotation. (NRCS, July 2010)

Payout structures are listed below: (USDA & NRCS, 2011)

For example one of the enhancement activities listed on the conservation stewardship practice list is critical area planting (CAP). It entails planting vegetative crop cover in targeted eroding zones to stabilize soil sediment from runoff and to improve habitat. Targeted areas are soils that cannot be stabilized using normal farming practices and left untreated pose severe risk of erosion or permanent soil damage. Payout is not determined by proximity stream channels or irrigation ditches as the goal is to reduce total erosion on the land. Potential critical soil erosion areas include dams, dikes, levees, stream banks, cuts, fills and large slopes.

Soil stabilization must be done with permanent vegetation seeded or planted 30 days after grading the targeted area. Grading is done for temporary stabilization to establish a permanent plant community. There are no restrictions on what cover is applied, but woody plants are suggested for long term low maintained stabilization. However, grasses and legumes are the favored crops. This mixture is suggested due to the nitrogen fixing properties of legumes that lower the nitrogen fertilizer needs of the system. Also, mulch must be added after seeding to stabilize the surface from erosion and increase the water holding capacity of the soil surface.

Heavy equipment is not allowed for use on slopes 3:1 or steeper. Seeding is limited to broadcast and hydro seeding and the plant cover must be low maintained, not requiring mowing. If hydro seeding, increasing the surface's roughness can increase recruitment. Conversely, planting is allowed in lieu of seeding. Cover is not considered successfully planted until it has been in place for over a year. In areas where the crop has to establish it is up to the farmer to repair and reseed the target area. Shrubs can be used to establish windbreaks as well, which is considered another enhancements with its own rules, criteria, and point values. Likewise in areas where turf, or shrubs cannot be established, vines can be used as a groundcover (NRCS, Sept. 2010).

By CMT point values, CAP represents a potential 35 points over six of the eight priority resource concerns. No resource concerns are met for either water quantity or energy according to NRCS. For soil erosion concerns, CAP can represent a possible 19 points. Five points are given for sheet, rill, wind, irrigation issues and ephemeral, gully issues. CAP stabilizes the upper soil and is shown to lower soil displacement due to wind and runoff (Shields et al., 2008). Four points go to streambank, shoreline issues, and five go towards road banks, construction site issues. Still, it is only possible to get these points if any of the issues of concern are present and contain CAP cover. It is unlikely but not impossible to get the full 19 point value. However, with a lower value of nine points, it still has the most points per priority conservation concern and if soil erosion concerns are a priority concern for the state or NRCS sub-region, it can lead to an increased consideration and payout for the applicant (NRCS, Dec. 2010).

For soil quality functions, CAP enhancements are worth four points. Three points are for organic matter depletion, and one point is for salinity, contaminants issues. The three organic matter points are due to an increase in vegetation on the ground. Organic matter depletion is dependent upon habitat, compaction and water partitioning. CAP creates new habitats and fights compaction of soils, as root growth promotes granular soil structure and colloid formation. The structure allows for the water to pass through preferential flow areas and organic material can proliferate in the soil. While CAP reduces erosion, it does not lower salts or contaminants in the soil except that which the cover takes up. The plants are designed to be permanent so they cannot be culled to remove the materials from the site. Since the cover helps this issue somewhat it receives one point. Soil water quality functions are also worth four points under CAP for sediment issues due to soil erosion control.

Air quality concerns are awarded three points by CAP enhancements. They are all for airborne soil particulate concerns. Just as vegetative cover reduces erosion from runoff, it also reduces erosion from wind shear. It is worth less points though since the critical areas are more designated for soil stability and overland flow than wind vulnerability. However there is also a bit of crossover between CAP and windbreak enhancement activities if the shrubs are employed as cover, which can increase the air quality priority concern points for the same instillation. Two points are awarded for planting and increasing quantity, diversity, health, and vigor. Well three points are awarded for addressing animal concerns. There is one point for terrestrial wildlife due to increasing cover and connectivity, and two points for aquatic wildlife mostly for erosion concerns.

The five priority resource concerns for the state of Montana are soil erosion, soil quality, water quality, plants (biodiversity), and animal concerns. Thirty-two of the potential thirty five possible CMT points possible under CAP enhancements are one of Montana's listed priority resource concerns. It is impossible to tell how much the payout would be since it is weighted against past performance. Also, nine of the points are only possible if the proper installations are on the site. However, since projected costs are paid back for the enhancement if it was carried out during the CSP contract and potential lost revenue is taken into count, the cost to the contract holder is easily less than the long term payout. This is especially true when considering these installations are meant to be permanent and can be extended between CSP contract periods if the program is continued by the US government.

<u>Pesticide Use in Montana</u>

Over 5.7 million of Montana's 94 million total acres is involved in wheat production (USDA Ag. Census, 2007). With so much of the state's land used for production, it is important to understand the impacts incurred through various farming practices. The problems typically of greatest concern related to wheat production and water quality are: erosion/sediment loss, nutrient loss (typically N and P), and the leaching/runoff of inorganic compounds in the form of pesticides.

Chemical research and distribution companies like Monsanto lead the industry in the rapid development of new and more effective/efficient chemicals for managing different types of agricultural pests. Seemingly often, sometime after introduction and widespread use of an agrichemical, scientific research surfaces exposing the incredibly negative (often carcinogenic) effects of exposure to the chemical or one of its intermediate forms. For many years, ending in the 1990's one very popular herbicide used nationwide was Atrazine, until a great deal of research exposed Atrazine as having very negative effects on the reproductive systems of aquatic organisms (NRDC, 2009).

Right now in Montana the most widely used herbicide is Roundup® made by Monsanto Corporation, the active ingredient in which is the isopropylamine salt, also known as glyphosate. Glyphosate has a relatively short residence time and is regarded by many farmers and land managers to be a relatively benign chemical compound, but there is some evidence that suggests it may have detrimental ecological effects.

Glyphosate is a broad spectrum, non-selective systemic herbicide which acts on certain plant enzymes responsible for protein synthesis (Schuette, 1998). It is applied and absorbed through foliar plant tissues where it is transported to meristematic tissue cells. Specifically, it disrupts the shikimic acid pathway which is a precursor to the synthesis to of aromatic amino acids, which are the precursors to plant essential proteins. It is effective on essentially all annual and perennial plants including grasses, sedges, broad-leafed weeds and woody plants (Schuette, 1998). Glyphosate is the active ingredient in the commercially available formulated products Rodeo®, Pondmaster®, Vision®, Accord®, and Roundup®.

Typically glyphosate products are used on crops that have been genetically modified to be resistant to the herbicide's mode of action. However, there is no glyphosate resistant wheat variety available for production. In Montana wheat systems, glyphosate is typically used as pre- and post-crop weed control, and largely as weed control during fallow periods. It is used especially heavily in no till systems where soil erosion and moisture retention are of primary concern. Since it is widely used on virtually all types of cropping systems (aside from organic), there is an inherent risk that some of it can leach or run off into surface and ground water systems. For that reason it is important to understand the environmental fate of glyphosate in soil and water systems.

According to Schuette (1998), glyphosate is only moderately soluble in common organic solvents like acetone and chlorobenzene. It has a high soil adsorption coefficient (Kd=61 g/cm3) and a very low octanol/water coefficient (Kow=0.00033). These numbers suggest that glyphosate has low mobility and only a slight tendency to leach out of soils, because it binds very tightly to soil particles. However, glyphosate is highly soluble in water. Glyphosate is described as being stable in water at a range of pH values and is also considered stable to photodegradation in water. Studies suggest that glyphosate's loss from water is primarily through sediment adsorption and microbial degradation (Schuette, 1998). In natural waters tests by the Environmental Protection Agency (EPA), the half-life of glyphosate was 35-63 days. For all aquatic systems, sediment was found to be the major sink for glyphosate residues (Schuette, 1998). The degradation, primarily microbial, of glyphosate yields multiple intermediates and eventually results in NH_3, Phosphorus, and CO_2.

According to Rick Mulder, head of Water Quality for Montana's Department of Agriculture, glyphosate was not being tested for several years up until 2009, when he decided that it should be put back on the list of chemicals to sample for. Since then, there have been no detections of glyphosate in natural surface or ground waters. However, Mr. Mulder indicated that in 2011, samples of storm flows detected glyphosate in significant levels. No conclusive reason was given as to why it is only being detected in storm flows.

Single-dose acute oral studies conducted for the EPA's Registration Eligibility Decision (RED) indicate that glyphosate is practically non-toxic to upland birds and only slightly toxic to waterfowl. Tests on warm and cold water fish indicate that glyphosate is slightly to practically non-toxic to both types (Folmar et al., 1979). Glyphosate's low octanol/water coefficient and low fat (lipids) solubility indicate that it has a very low tendency to bioaccumulate (Schuette, 1998).

A study performed by the USDA to determine the toxicity of glyphosate to mammals observed no cellular changes in mice fed glyphosate at a concentration of up to 300 ppm in the diet for 18 months. When glyphosate is formulated as in Roundup®, Vision®, or Accord®, it becomes more toxic to animal species due to the presence of surfactants. Surfactants are typically petroleum-based compounds, which act to reduce surface tension in a solution, in this case to ease application. In a study conducted for the EPA's RED, the formulated surfactant MONO818 is slightly toxic to the invertebrate *Daphnia magna* and moderately toxic to rainbow trout. In these cases toxicity is highly dependent on pH (Folmar et al., 1979). The EPA has set a drinking water Health Advisory (HA) for glyphosate at 800 ppb for effects other than cancer risk. Glyphosate is listed in EPA's group D for cancer risk, which means there is not enough evidence to demonstrate that it is a cancer risk (Schuette, 1998). Nearly all the research available reports glyphosate as essentially nontoxic to most organisms. However, one study performed by a French research group documents the differential effects of glyphosate on human placental cells and aromatase (Richard et al., 2005).

Aromatase is an enzyme responsible for a key step in the biosynthesis of estrogens. This study concluded that glyphosate acts as a disruptor of the mammalian cytochrome P450 aromatase activity from concentrations 10 times lower than the recommended agricultural use. It can also affect aromatase gene expression. It was determined that glyphosate in Roundup® formulation may multiply its endocrine effect, and that Roundup® is considered a potential endocrine disruptor. Furthermore, at higher concentrations (still well below classical agricultural dilutions), the toxicity of Roundup® on placental cells could induce reproductive problems (Richard et al., 2005).

What effects, if any, have CSP incentives had on glyphosate use since wide scale implementation of CSP in last decade? With the future of CSP and other conservation programs being so precarious, what might the effects be if the loss of these incentives becomes a reality? These are important questions to consider when we think about the future of large-scale wheat farming practices in the state. It has been demonstrated that glyphosate can have negative effects not only on aquatic organisms, but on humans as well. If CSP incentives have inspired farmers to use lower concentrations of herbicides and explore alternate weed control methods, what will happen to quantities of applied agrichemicals if these programs are ended? In the end these environmental problems are products of human design. Only when people are fully aware of the negativity of certain agricultural practices, can they take a stand to inspire far-reaching change within the current, corporate run, “big agriculture” paradigm.

Fish and Wildlife Concerns

In Montana, agriculture systems are a source of nutrient pollution to water bodies that can be toxic to fish. Water quality is critical to fish health. Water quality standards are set by each state to regulate the cleanliness and the purity of the water body. The standards are influenced by water use, water quality criteria are to protect those uses and determine if they are being maintained (EPA, 2011). Typical water uses include protection and propagation of aquatic species, wildlife, recreation, and water supply for public use, agriculture and industry (EPA, 2011).

Water draining from agricultural lands and into surrounding water bodies can cause a buildup of toxins, as well as cause reproductive and developmental problems in fish (Fish and Wildlife, 2011). Nitrogen is highly mobile nutrient that can be volatilized or leached into surface water and ground water. A significant proportion of a poorly timed nitrogen fertilizer applications can be lost via leaching and runoff before the target crop has a chance to use it (Lory and Cromley, 2006). Also if excessive nitrogen is applied, the unused nitrogen can be lost through runoff into nearby rivers and streams.

Once in a stream, nitrogen can become a dissolved gas that becomes problematic if its levels are above 110 percent (Swann, 2011). Gas bubble disease is a symptom of gas super saturation. The signs of gas bubble disease can vary, bubbles may reach the heart or brain, and fish die without any visible external signs. Other symptoms may be bubbles just under the surface of the skin, in the eyes, or between the fin rays (Swann, 2011).

Ammonia, which is a form of nitrogen in the gas phase, may pollute rivers and be of organic origin, like agricultural wastes, excess fertilizers and livestock waste (Svobodova, 2011). Molecular ammonia (NH_3) can readily diffuse across the tissue barriers where a concentration gradient exists, and can be toxic to fish at high enough levels. Ammonia has a toxic effect on the brain (Swann, 2011). Improving nitrogen management improves both water quality and the effectiveness of fertilizer nitrogen for meeting agronomic goals (Lory and Cromley, 2006).

Agriculture based chemicals, like glyphosate, end up in nearby stream and rivers through leaching or runoff from fields with excess chemicals. Montana farmers use glyphosate to kill weeds, especially annual broadleaf weeds and grasses known to compete with crops (EPA, 2011). Glyphosate may enter aquatic systems through accidental spraying, spray drift, or surface runoff. It dissipates rapidly from the water column as a result of adsorption and biodegradation. The half-life in an aquatic environment for glyphosate is 7 days (Patterson, 2004). Sediment is the primary sink for glyphosate. After spraying, glyphosate levels in sediment rise and then decline to low levels in a few months. Due to its ionic state in water, glyphosate would not be expected to volatilize from water or soil. Based on its water solubility, glyphosate is not expected to bioaccumulate in aquatic organisms. It is minimally retained and rapidly eliminated in fish, birds, and mammals. The glyphosate in fish following a 10-14 day exposure period was 0.2 to 0.3 (Patterson, 2004).

Water quality is a major component of the CSP program. Farmers can apply multiple types of enhancements that will help improve the water quality, and improve fish habitat and health. Some enhancements that a farmer might implement are: 1) to apply nutrients no more than 30 days prior to planting; 2) to use controlled release nitrogen; 3) to grow cover crops to scavenge nitrogen; 4) to use precision agriculture nutrient application; 5) to reduce nutrient concentrations and 6) to use a legume as a nitrogen source (NRCS, 2011). Each of these enhancements limits the amount of nutrients that are applied to crops to prevent excess nutrient runoff into water bodies. For example precision agriculture nutrient application is a farm management concept based on observing and responding to field variations. It relies on new technologies like satellite imagery, information technology, and geospatial tools. It is also aided by farmers' ability to locate their precise position in a field using satellite positioning system like GPS.

The United States Department of Agriculture (USDA) NRCS is devoted to improving agricultural practices to increase crop production. One of ways they do this is working directly with landowners to fund their conservation efforts. CSP is a voluntary conservation program funded by the Farm Bill and administered by the NRCS that offers payments to producers who currently implement conservation practices (www.nrcs.usda.gov). Lands eligible to adopt CSP include cropland, pastureland, rangeland, and non-industrial forestland. Through CSP, NRCS will be able to provide technical and financial assistance to address resource and environmental concerns (www.nrcs.usda.gov). To efficiently deal with the wide range of environmental issues, the CSP program is administered via enhancements. Enhancements are activity sheets that direct the land owner on how to accomplish his/her goals and what requirements must be met.

Enhancements include methods of improving air quality, animal production, soil erosion and quality, energy, plants, and water quality. While these enhancements are listed under the above concerns, many have indirect benefits, such as wildlife habitat enhancement, that are not specifically categorized as so. Wildlife habitat enhancement falls under many of the conservation issues, as each enhancement increases wildlife habitat conditions, recruitment of wildlife species in the area also increases. Data provided by the NRCS shows the number of acres each type of enhancement resulting in wildlife habitat improvement was applied to over the last three fiscal years in Montana (Table 1).

The total number of acres implementing animal enhancements was 84.62% of the total area implemented with CSP measures, of which, 15% was cropland (Table 1). These programs enhance wildlife habitat, especially presence of food and cover. Examples of such enhancements include harvesting hay in a manner to safely flush wildlife, modifying stock tanks to allow wildlife to escape, creating wildlife corridors to permit migration, and restoring habitat for food and cover.

Soil quality enhancements account for 13% of the total area using CSP, 99.88% of which was cropland (Table 1). These enhancements focus on improving different soil aspects, for example, seeding deep rooted plants to decrease compaction, or altering production methods to reduce erosion and other detrimental soil effects. Water quality enhancements include methods to improve riparian areas and decrease runoff contamination. Water quality enhancements were applied on 2.3% of the total area using CSP, of which, 12.48% was cropland (Table 1). Over the last three fiscal years, about 26% of the 251,554.9 acres of land implemented with CSP wildlife enhancement measures were cropland (Table 1). Such a commitment to conservation methods is encouraging; it shows a significant interest in methods to improve agricultural practices to develop wildlife habitat.

Acres of Applied Wildlife Enhancements in Montana			
CSP Enhancement	**Acres of Cropland (Hay land)**	**Acres of Cropland**	**Total Acres Applied**
Animal Enhancement			
Total	11,014.6	32,071.6	212,872.0
Soil Enhancement			
Total	0.0	32,834.4	32,871.4
Wetland, Riparian, and Other Water Quality Enhancements			
Total	0.0	725.3	5,811.5
Overall Total	11,014.6	65,631.3	251,554.9

Table 1: Acres, provided by Joseph Fidel, Resource Conservationist of the Bozeman Montana Area NRCS Office, of applied wildlife enhancements; implemented over the last three fiscal years in Montana.

Many of the enhancements implemented by CSP can improve wildlife habitat, potentially leading to higher recruitment of wildlife species. While the general public usually recognizes the importance of wildlife conservation, not all wildlife species are equally treated; species often overlooked are insect pollinators. Insect pollinators provide ecological services to agricultural producers and natural ecosystems by increasing seed sets and yield, maintaining plant species viability and sustainability through pollination. Many agricultural areas suffer from a lack of sustainable pollination systems, resulting from a shortage on managed, indigenous, or imported pollinators (Kevan et al., 2001). This decrease in pollinators could have serious consequences in agricultural areas, influencing global crop production, thus affecting a good portion of food consumed in the human diet and global food markets (Aizen et al., 2008; Gallai et al., 2009). This decline can also affect the maintenance of wild plant diversity and ecological stability (Potts et al., 2010).

The first CSP enhancement directly encouraging improvement of habitat for pollinators is PLT01. The increase in pollinators can lead to higher quality fruit and productivity per acre. This improvement in habitat will also provide a food base for additional wildlife species and may increase populations of other beneficial insects, reducing the need for pesticides. According to the *2011 CSP Montana Enhancement Workbook*, this is accomplished by seeding vegetation favored by insect pollinators, for example, species reliant on insect pollination for reproduction, often producing pollen with high amounts of nectar. These plants are seeded in non-cropped areas, such as field borders, buffer strips, riparian vegetation, and other cover buffers.

The second enhancement leading to habitat improvement for insects is PLT08, which focuses on increasing habitat suitable for beneficial insects used for pest management. For example, wheat stem sawflies inhabit the upper portions of wheat stubble; their habitat is created when wheat is cut higher on the stem (USDA, 2011). By altering harvest practices, wheat stem sawfly populations can be controlled. Other habitat development activities are specific to the pest in question and are applied based on recommendations from land grant university experts. While the CSP program offers ways to improve wildlife concerns, there are other Farm Bill programs available for landowners address issues with wildlife. Two popular programs are the Conservation Reserve Program (CRP) and the Environmental Quality Incentives Program (EQIP).

The CRP program provides technical and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns (USDA, 2011). This program reduces soil erosion, protects the nation's ability produce food, reduces sedimentation in streams and lakes, improves water quality, establishes wildlife habitat, and enhances forest and wetland resources (USDA & NRCS, 2011). It encourages farmers to convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover, such as tame or native grasses, wildlife plantings, trees, filterstrips, or riparian buffers (USDA NRCS, 2011). The Commodity Credit Corporation (CCC) provides participants with annual rental payments and cost-share assistance for implementing approved conservation practices (www.fsa.usda.gov). The rental payments are based on the agricultural rental value of the land and up to 50% of the establishment cost can be covered by cost-share assistance. Participants enroll in CRP contracts for ten to fifteen years (www.fsa.usda.gov). CRP is administered by the Farm Service Agency (FSA), with technical assistance provided by the NRCS (USDA & NRCS, 2011).

EQIP promotes agricultural production, forest management, and improvements to environmental quality. EQIP aids farmers and ranchers meet Federal, State, Tribal, and local environmental regulations (USDA & NRCS, 2011). Through EQIP, NRCS provides financial and technical assistance to farmers, ranchers, and other land owners who face threats to wildlife habitat, surface and groundwater conservation, energy conservation, soil, water, and air quality, and other natural resource concerns on their land (USDA & NRCS, 2011).

By working with federal agencies, such as the FSA and NRCS, agricultural producers, private landowners, and other interested parties can implement conservation measures to improve natural resources, habitats, increase production, and collect some monetary compensation for their actions. This provides a good incentive to retain current CSP operators and cultivate new ones. Since, we share our land with wildlife, we must find a compromise between our needs and theirs. More specifically, we must find a compromise in land use between wildlife habitat and human use. In market economies, prices are normally used to provide signals regarding resource availability. In situations regarding natural resources, however, these signals are often unclear. While no reasonable amount of effort will produce very precise estimates of wetland values (Costanza, 1989), it is possible to estimate their value to society by researching the agendas, funding inputs and opportunity costs associated with their preservation.

The Conservation Reserve and Wetland Reserve Programs (CRP & WRP) are the two main programs in the U.S. focused on withdrawing land from active agricultural use and allowing it to remain as a natural area. The primary goals of both CRP and WRP are to facilitate conservation and habitat protection; implied are the secondary goals of sustaining wildlife populations for the enjoyment of the nation's outdoor recreation enthusiasts. The reserve programs depend on public-private partnerships, including those formed between the public demand for habitat and private landholders, and those formed between private groups and private landholders. Private organizations such as the international, non-profit Ducks Unlimited have completed countless restoration and conservation projects in partnership with CRP and WRP (Ducks Unlimited, 2007). While it's true that many of these private groups are motivated by their own agenda, usually involving plentiful generations of waterfowl to be viewed or harvested, the positive externalities of the situation are immeasurable. For example, for each species of game animal using the habitat, there are countless other members of the local ecosystem benefiting.

Waterfowl populations were in decline during the early 1980s and this lead to the conception and execution of the North American Waterfowl Management Plan (NAWMP) by the United States and Canada, followed by Mexico. The plan identified wetland and grassland losses in the Prairie Pothole Region (PPR) of North America as the major causes of waterfowl population declines. Wetland loss, due primarily to drainage for conversion to cropland, had been estimated at 35% in the PPR of South Dakota and 49% in North Dakota (Dahl, 1990). Declining duck nest fecundity (dependent on the probability that greater than or equal to 1 egg in a nest hatches) throughout the PPR since 1935 has been a major factor in declining duck populations (Beauchamp et al., 1996). A subsequent study concluded that duck nest success throughout much of the U.S PPR was insufficient to maintain population levels for mallards (Anas platyrhynchos) and northern pintails (A. acuta) (Dahl. 1990).

By 1998, CRP was in full swing and waterfowl nest densities and nesting success in CRP fields was similar to those occurring in grassland habitats managed specifically for waterfowl. The presence of CRP grasslands has been postulated to have improved the quality of existing duck nest habitat by dispersing nests over a larger area (Burger et al., 1998). Most of these lands were retired marginal cropland. These lands were generally highly erodible, now more stable thanks to the permanent vegetation. This permanent vegetation also functions as excellent cover for upland nesting waterfowl and other wildlife (Schultz, 1990). The implied economic sacrifices and environmental benefits are difficult to compare in any quantitative fashion, even before becoming further confounded by the substantial recreation-based economic *gains* made by the trade-off, however there is a quality attributed to habitat preservation efforts which is impossible to put a price on, which is sustainability.

It's not a question of whether or not sustainable farming practices are possible to adopt, it's a question of what scale sustainable farming practice is actually attainable. What fraction of our fertile land can we actually work indefinitely? Have we passed the tipping point already? These questions are beyond the scope of this paper, but this question is not: How sustainable is natural habitat? Natural areas recycle and revitalize the elements that make up our biosphere, even making up for shortcomings in sustainability elsewhere. So the $2 billion of federal dollars spent on CRP and the $200 million spent on WRP (Ferris et al., 2009) are essentially going toward negating gaps in sustainability present in most of our other activities. This is not to say that human needs are not important. We would all like to sustain ourselves by eating food that was once grown on cropland. Rather, sustainability takes place on a time scale larger than between now and dinnertime and involves more than direct benefits to humans.

CRP and WRP are components of the Federal Farm Bill that, in collaboration with private organizations, fund an increase in the quantity of waterfowl-relevant ecosystem structures. That said, robust ecosystem structure is not the only factor contributing to flourishing populations of waterfowl. Another element necessary for waterfowl habitat conservation is ecosystem function, and while generally provided for by the mere existence of the habitat, another component of the Farm Bill exists to control these more qualitative aspects of waterfowl habitat preservation, including soil, water and air quality. CSP is charged with the task of forming similar partnerships with landowners, except that where CRP and WRP deal more with ecosystem quantity, CSP (having motivations and goals similar to

CRP/WRP) goes about accomplishing them not by the structural approach of CRP/WRP. Instead, CSP facilitates partnerships focused on minimizing harmful inputs to natural habitats (wetland habitats where applicable). If CSP functions in collaborative harmony with CRP/WRP, waterfowl will not only have a place to live but the means to thrive.

Over the past two centuries, agriculture in the United States has seen many changes. As the country grew, so did the farms. Research and innovation continued to speed up the pace for farmers who could now grow crops with a much higher yield. This fast pace growth, however, came with consequences to the land. Soil has been lost, water quality has gone down, and species diversity is suffering. However, with the right awareness, research and policy making, these environmental issues can be resolved. The Conservation Stewardship Program (previously the Conservation Security Program) is just one policy example that works towards addressing and resolving these issues.

Originally it was created to manage at risk watersheds, but has since been expanded to include every state. The CSP encourages producers to improve their conservation performance by installing and adopting additional conservative farming practices, and improving, maintaining, and managing water quality and wildlife habitat on agricultural land and nonindustrial private forest land. By improving soil structure and maintaining surface organic matter in the form of crop residues, we can increase infiltration and moisture content. No-till and conservation tilling, pulse crop rotations and inter-cropping can increase the productivity of soils in agriculture. Improving water quality through implementing different production systems and decreasing chemical contamination, benefits agricultural production, the environment, and habitat for wildlife species. Through these practices agriculture can continue to support growing human populations and sustain ecosystem functions for all species.

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