Developing Conservation Targets for Nutrients and Sediments in Cropland Planning: A Working Session
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During the production of agriculture commodities, crop and soil nutrients are required for successful harvest. Crop and soil nutrients are applied to promote crop yields and vegetation production and also to feed the soil's biology. The agricultural system is not 100% efficient; therefore some fertilizer, sediments, organics, and soil nutrients can escape and be lost from the system. Some of the nutrients are lost due to the intrinsic soil and climate properties such as rapid water percolation or high pH or high rainfall conditions. Other nutrients escape the system when inappropriate management takes place according to proper rate, form, timing, or method of nutrient application.

Adverse impacts are caused when nutrients destined for crop and soil fertility and utilization instead find their way into the water or air. Excess nutrients occurring in water is called eutrophication. Eutrophication has been identified as the main cause of surface water quality impairment. Eutrophication restricts water use for many desired uses like fishing, recreation, industry, and drinking because of increased growth of undesirable algae and aquatic weeds and the oxygen shortages caused by organic material death and decomposition. Air quality can be compromised when nitrogen is emitted as ammonia by volatilization and leaves the application site traveling downwind to be deposited in inadvertent locations.

A Start in the Development of Conservation Planning Targets

We in USDA with the help of our LGU and State partners are attempting to use part of our recently completed Natural Resource Inventory database on benefits of conservation effects assessment (CEAP) to establish planning target levels for resource management, including losses that occur while we produce food, forage, fiber, and fuel from our cropland. Our precedent of a conservation planning target is the soil erosion loss tolerance we have used for over 30 years to set an acceptable level for soil erosion that occurs within our landscape. Since we can never expect zero amounts of soil erosion, we are committed to farm below a threshold level for soil erosion. The "T" value not only establishes the acceptable level, it also is used to adjust the amount of conservation practices and management techniques necessary to use enabling our high level of crop productivity to be sustained economically and indefinitely.

The contaminants we are attempting to establish conservation planning target levels are sediment, nutrients, organics, and gasses. The difference is we are trying to set planning levels of contaminant losses through various fates and pathways, likewise permitting an acceptable level of crop production, but also to accept the lowest possible levels of environmental and economic degradation and impacts. As with soil erosion, the nutrient, sediment, and economic losses can not be completely eliminated. It is not as direct as wearing away of the resource base (soil erosion), but there exist the threat of polluting other resources of the ecosystem (water, air, plants) and losing valuable crop inputs (nutrients, soil, carbon) are resource concerns. The thinking is, if there is an acceptable level of management then we can plan adequate conservation and management to achieve that level, just like we have planned our conservation measures to adjust to the soil loss tolerance level of "T".

Can this be done? We need to do some critical thinking about this. This is why we are starting with this austere group during our Tuesday symposium at SWCS annual meeting. To think. To talk. To worry. There has to be a level of trepidation. What if these "conservation planning target levels of contaminants" become the level of no return? The law? The unacceptable, fixed level of pollution and farming control? We worry, too. But, If the scientific community don't contribute to science and wisdom of establishing target levels of management we may be the ones defending some other basis for setting conservation planning criteria or a more arbitrary way of arriving

at a set level of conservation. We are trying to step out in front of this issue (avoiding trucks, tractors, and buses).

Searching for the Concept

Setting acceptable conservation planning levels would place specific nutrient loss quantities on total nutrient loads through various loss pathways. These levels represent a planning goal for resource conservation protection while providing adequate nutrients for crop production to be communicated to producers for enabling implementation of management systems and conservation practices that protect the soil, water, and air resources of the basin. Different levels of nutrient losses could be set to match the local specific resource protection needs of a watershed, cropped areas, or soil associations. These levels would relate to the sensitivity of the resource base such as water quality for drinking, air emissions standards, soil quality, etc. Using these levels we could determine where conservation treatment and management techniques need to be targeted and implemented to avoid adverse impacts from nutrient on the environment and avoid production losses.

Conservation planning targets levels of contaminants are defined as the amount of contaminant, most often in pounds per acre, which can be moved off the edge of the field defined by model output without a significant impact to the off-site resources. Here off-site is considered out of the agriculture management zone (AMZ) which is defined as off the edge of the field, below the bottom of the root zone, and above the plant canopy. This does not imply that an accumulation of all contaminants leaving the field would do no environmental harm, but that individual contaminants, by themselves, pose little or no environmental stress on the resources. The setting of threshold levels of contaminant movement beyond the AMZ is used to determine on a broad basis how many acres of cropland in this country will require additional conservation treatment to solve individual resource conservation concerns. This may be determined by analyzing the amount of cropland acres that have current conditions (both intrinsic soil and climate factors as well as management techniques) that result in an exceedence of a critical contaminant level. A computer model or planning index will analyze each point over a period of climatic years and average the contaminant load over the period of years. Any acre that exceeds the critical planning target would require conservation and management treatment to

alleviate additional excess nutrient loss from the site. This treatment can be in the form of source control, where the rate, form, timing, and method of application follows locally acceptable management practices, or treatment could involve a restriction of the transport mechanisms that move the contaminant from the source site to the edge of the AMZ. In both cases intervention by the producer is necessary to reduce the level of contaminant export to a planning threshold level.

Setting conservation planning levels for acres of cropland has been initiated by looking at literature values from various monitored experiments. In some studies a critical level of loss was defined for that particular watershed setting. Other studies have monitored the range of loss potential based on various treatments that involve rate, timing, form, and method of application. As can be imagined, throughout the national and other countries, there is a wide variance in nutrient loss potentials given the broad properties of soils, climate, and cropping systems. In certain cases established limits have been defined and presented in index forms.

Setting the Initial Planning Target Levels

Setting one conservation planning level of contaminant loss across the entire cropland area of the USA is a daunting task. There are no uniformities in climates, soils, and cropping systems across the extent of the cropland acres. Neither is there consistent water quality concern that would impart an uniform impact per unit of contaminant within the cropland area of influences. Thus the idea of setting only one acceptable planning level throughout the cropland acres of the USA hardly can be used. But generally, it may give a broad estimate of the number of cropland acres that exceed a set level, and subsequently would require conservation practices and management techniques to mitigate the impact of the loss of excessive contaminants. An iteration of conservation practices and management techniques (e.g., erosion control, tillage, application management) on the identified sites can then be used to ascertain the extent of treatment necessary to solve the current assessed situation.

Setting one single planning target level for all regions of the country, considering the soil, climate, cropping systems, and management skills is very tenuous. There can be arduous debate on whether the levels are realistic, too low or too liberal, or not matching local research studies. Of course, setting the planning level of nutrient loss too low would place an

extraordinary number of cropland acres in need of additional conservation practices and management techniques.

This setting of planning target levels is to determine, on a broad basis, how much additional work needs to be done to solve individual resource conservation concerns. It matches the sensitive intrinsic conditions of soil, climate, and cropping systems with the risky behavior of the resource manager. Sensitive site conditions for leaching, runoff, or erosion (such as coarse textured or sloping soils) when matched with risky behavior (such as excessive rates, poor timing, or inappropriate form of nutrients) can cause high levels of contaminant load losses from the field. If any model results in contaminant levels greater than the level shown above, then that model run with its associated acres of influence is considered "unacceptable" and will require conservation treatment. Conservation treatment can consist of application of conservation practices, such as residue management or cover crops, or management techniques such as managing the rate, timing, form, and method of agrichemical inputs.

There has never been a national or regional water quality or air quality standard set for edge of field losses. US EPA is currently developing Ecoregion Nutrient Criteria for 14 regions of the country. Nutrient criteria for EPA ecoregions are numerical values associated with prevention and assessment of eutrophic conditions in two types of water bodies, rivers and lakes. The basis for criteria of contaminant levels was selected from a vast review of the literature for waters in particular water bodies. These values used for conservation planning of contaminant loss from the AMZ should not be confused with EPA's Ecoregional Nutrient Criteria for national water bodies. EPA is developing nutrient criteria in each ecoregion to determine a best estimate of minimally impacted conditions within the water body. What contaminant level will impact the water body. There is a disconnect between what contaminant losses leave the agricultural management zone (AMZ) and how this contaminant impacts the water body. (EPA, 2007).

http://www.epa.gov.waterscience/criteria/nutrient/database/select_state.html

A precedence in setting and using a "target level" in conservation planning

These planning targets take on the same communication function as the soil loss tolerance "T" in the Revised Universal Soil Loss Equation (RUSLE)

where the ‘maximum allowable loss’ of soil by erosion along the designated slope is compared to the soil loss tolerance ‘T’ value. A soil loss value above the tolerance less is considered unacceptable and unable to maintain economic production over a long term. After an assessment is made by appropriate nutrient loss pathway assessment tools, the loss can be compared to the level of acceptable loss for that field (or pathway) and determined if the assessed loss exceeds or is less than the soil loss tolerance level. Any level of loss that is greater than this level can be targeted for remediation and apply conservation practices to the loss pathway or deal with the source of the contaminant through managing the rate, form, timing, and method of nutrient application. The term “soil loss tolerance” denotes the maximum level of soil erosion that will permit a high level of crop productivity to be sustained economically and indefinitely. The major purpose of the soil loss equation is to guide methodical decision making in conservation planning on a site basis. The soil loss equation enables the planner to predict the average rate of soil erosion for each of various alternative combinations of crop systems, management techniques, and erosion control practices. When these predictive losses are compared to a soil loss tolerance for the site they provide specific guidance for effecting erosion control.

A question remains whether to treat the resource needs as the total contaminate loss level, i.e., pounds of total nitrogen or phosphorus per acre, regardless of the source of contamination, or treat each loss at the pathway level. Thereby, nitrate nitrogen leaching would have a maximum contaminate level, expressed in pounds per acre, as well as ammonia nitrogen volatilized, and sediment attached ammonium. The advantage of setting this detail of contaminate levels is that each form of nutrient (sediment attached, soluble, gaseous) and loss pathway (erosion, leaching, volatilization) would require a particular set of conservation practices and management technique to overcome the loss. Sub-target levels for a number of pathways may, in fact, exceed a total level of loss for the particular nutrient. For the producer this would be an important revelation because it would detract from the total amount of nutrient that could be available for crop uptake and utilization and for soil reserve. Depending on the sensitivity of the assessment tool, it would be more instructive to set acceptable planning target levels at the pathway level and then compare losses in order to make management decisions when these target losses are exceeded.

Iteration of various conservation and management techniques in the targeted area until the assessment tool (or on-site monitoring) reveals that the level of contamination loss is below the planning level. This is similar to how conservation planning is accomplished for soil erosion when the Revised Universal Soil Loss Equation (RUSLE) or the Wind Erosion Prediction System (WEPS) are used to assess the resource area while conservation measures are added to the resource management system until the average annual erosion rate in tons per acre per year is below the tolerable level "T".

Determining Future Conservation and Management Treatment Needs

An inventory of current conservation and management conditions can lead to an assessment of additional treatment measures that will reduce to an allowable planned minimum the off-site and on-site degradation of our natural resources. The inventory will describe the current conditions taking place during the management and production of the crop. By establishing planning level of fate and transport loss from the production area (the AMZ) the current inventory can be compared to a target level. If the current level is less than the target level then the production system is deemed sustainable. If, however, the current level of production is creating greater losses than the targeted planning levels some form of conservation practice and/or management technique must be put in place to reduce the loss potential to a level below the level. This way the level of contaminant losses becomes the key level for conservation planning and management adjustment.

While research and monitoring has reported various levels of contaminant losses from edge of field, bottom or root zone, and top of crop canopy these planning target levels are set to depict both environmental and economic impacts of such movement from the field. As input cost for crop nutrients increase these loss nutrient contaminants become more valuable to the producer. And, as the cost of mitigating environmental damages become more costly, the price of allowing contaminants such as sediment, organic material, and crop nutrients to escape into the environment again will escalate. These initial target values are set to offer a planning target for establishing conservation practices and management actions. This major study within the Mississippi River basin strongly supports the implementation of conservation and management actions to reduce the amount of contaminates from leaving the agricultural management zone (edge of field, bottom of root zone, and top of crop canopy). If deemed

necessary, the current ‘planning targets’ can be adjusted to meet locale and changing economic and environmental conditions. This should not be done without first discussion about the local landscape, climate, and cropping conditions.

A Fear of the Planning Target

There is a trepidation that setting an planning target level of allowable nutrient loss could directly evolve into a politically formulated level of regulation. This could happen. If the science is solid during the deliberations and as a result of best professional judgments on the part of soil, agronomy, and water quality scientist, these target levels are identified, therefore the decision to regulate this level becomes the liability of the legislation of the politicians, not the scientist. In lieu of any scientific basis to set attainable levels of contamination by solely regulations will always fall short of best professional judgment. It is envisioned the setting of planning targets levels will target the landscapes where conservation is required. It will also set the level of conservation and management needed to sustain the contamination below target level, and it will also advise the land manager when their responsibility to contain nutrient is obtained.