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Method development for the detection and characterization of manufactured zinc oxide nanoparticles in soil-preliminary research results

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Manufactured zinc oxide nanoparticles (ZnO-NPs) are considered among the most widely used nanoparticles in many applications like consumer health care products, paints, electronics and others. While numerous studies have focused on potential adverse effects of MNPs in the environment, there are also potential beneficial uses of MNPs. Zinc is a vital micronutrient in plant nutrition and in the human diet. However, plants and humans suffer from Zn deficiency on a worldwide scale. This can be ascribed to low soil Zn reserves and/or low bioavailability of Zn for plant uptake. Despite the tremendous effort attempting to enhance plant Zn content through agronomic fortification approaches (i.e. use of Zn-fertilizer), Zn deficiency is still a global problem. In this research, we will investigate potential biofortification of some staple crops such as wheat (*Triticum aestivum*) and potato (*Solanum tuberosum*) with surface modified ZnO MNPs. One critical component of this research is to develop a reliable method to characterize and understand the behavior of surface coated ZnO MNPs in the soil and within plants. Here we present preliminary results that are a part of our effort to develop methods for characterization of ZnO NPs in soil using field flow fractionation techniques.

Overview of Community and Economic Development Programming in Southern Land-Grant Universities

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Modern budget constraints make it imperative to measure contributions made by community and economic development (CED) extension programs. As a first step, this article surveys CED programming in continental land-grant universities associated with the Southern Rural Development Center. Comparing program information from the universities' Plan of Work and extension websites, this article identifies regional trends in eight CED focus areas, finding widespread emphasis on entrepreneurship, emerging interest in environmental planning and differences in specialization between smaller and larger universities. This overview provides the analytical framework to highlight innovation and areas of future growth in CED programming throughout the Southern region.

Keywords: Community and economic development, land-grant university, cooperative extension, Southern Rural Development Center, qualitative research

The Role of Surface Chemistry in the Toxicity of CeO_2 Nanoparticles to Caenorhabditis elegans

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Manufactured ceria (CeO_2) nanoparticles (NP) are valued for their ability to transition between +3 and +4 oxidation states, rendering them a useful catalyst. To promote stability and decrease aggregation, surface coatings are applied to NPs. The charge of surface coatings can affect bioaccumulation of CeO_2 NPs and toxicity to soil dwelling organisms. We synthesized 4 nm CeO_2 coated with neutral 10 kDa dextran (DEX) (ζ potential =-0.731 mV in DI H_2O, pH 6.88), positively charged diethylaminoethyl-dextran (DEAE) (+26.9 mV in DI H_2O, pH 7.41) or negatively charged carboxymethyl-dextran (CM) (-29.3 mV in DI H_2O, pH 6.19). The particles were characterized by transmission electron microscopy, dynamic light scattering, and phase analysis light scattering (to determine ζ potential). We exposed the model organism Caenorhabditis elegans to DEX-, DEAE-, and CM- coated CeO_2 in reconstituted moderately hard water for 48 hours. DEAE-CeO_2 was more lethal than both DEX- and CM-CeO_2, likely due to positively charged particles interacting more with cell membranes. We observed increases in mortality at DEAE-CeO_2 concentrations as low as 50 mg/L while little mortality was observed for the Dex-CeO_2 treatment at concentrations of up to 500 mg/L. We observed little mortality for CM-CeO_2 particles up to 750 mg/L. Reproduction rates were examined. We observed a decrease with DEAE-CeO_2 at 2.5 mg/L. DEX- and CM-CeO_2 also induced a lower reproduction rate, but required 500 mg/L and 750 mg/L respectively. We concluded that positively charged surface coatings increase the toxicity of CeO_2 NPs, while negatively charged or neutral coatings decrease toxicity.

Soil-to-Atmosphere Greenhouse Gas Emissions from High- and Low-Input Turf Systems of Central Kentucky

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Lawns cover 20 million ha in the US, at least three times more area than other irrigated crops. Lawns can require significant water and energy resources and, under some conditions, may contribute negatively to regional eutrophication and air pollution issues. This project quantified how turf species and management regimes influence soil CO_2 and N_2O emissions from lawns in the transitional climatic zone of the eastern US.

Three replicate plots of tall fescue [Schedonorus arundinaceus], Kentucky bluegrass [Poa pratensis], and an endemic multi-species stand were established in the spring of 2012 in Lexington, KY. These lawn types were managed as either high-(tall fescue, Kentucky bluegrass) or low-maintenance (endemic) systems. High maintenance plots received regular pesticide and fertility treatments applied by a local lawn company. Fescue and bluegrass plots were irrigated. The low maintenance plots received none of these treatments. All plots were mowed as needed. CO_2 and N_2O efflux measurements were taken from February 2013 until August 2013 using a photoacoustic spectroscopy gas analyzer.

There were no significant differences in trace gas fluxes between high maintenance stands, but there were late summer differences between high- and low-maintenance stands. The high maintenance stands maintained higher CO_2 flux rates than low maintenance stands when rains became less regular. Two spring and summer applications of nitrogen (1/4lb 1000ft-2) did not stimulate any additional emissions. These results suggest that the environmental impacts of these three turf systems, from a trace gas perspective, are similar under wet conditions, but differences arise under extended dry periods.

A Queuing Model for Systems with Rework and Process Downtime: Waste Reduction for Improved Sustainability

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Response time has become a major leveraging factor to organizations seeking competitive advantage. Two common issues which act to increase lead time and diminish responsiveness are rework and machine downtime. These issues create waste that affects the organization financially and increases the sustainable impact through excessive use of resources. Environmentally, rework expends extra material and energy for both processing and transportation. From the societal viewpoint, rework increases burden on employees, possibly forcing overtime and exposing operators to greater hazard, decreasing morale, motivation, and job satisfaction. Machine downtime can create costly disruptions that propagate down the line, adding stress to the system. Preventative measures can reduce these effects, but with the complexity inherent in manufacturing systems it may not be obvious how to allocate resources for improvement efforts. Queuing models can be used to enhance understanding of the effects of rework and downtime by incorporating elements of variability.

In many cases queuing models can be used to study manufacturing environments but have often been overshadowed by Discrete Event Simulation (DES) due to the capability of DES to incorporate more realistic specifications. However, this complexity acts as a double-edged sword making it cumbersome or impossible to explore the total range of possible scenarios. Used as a preliminary modeling tool, queuing models could help to explore the possibilities thereby providing direction for later detailed DES analysis. Unfortunately, exact solutions from queuing theory exist only for systems with assumptions such as for exponential service and arrival times. Approximations have been developed to relieve some of these limitations. The major contribution of this work is the specification of a queuing model that combines different approximations for rework and downtime. The accuracy of the model is tested vs. simulation results under varying conditions.

Simulation Modeling for Improved Biorefinery Supply Chain Design

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In the literature, chemical process modeling has been conducted to determine operating conditions and costs for the production of biofuels utilizing various technologies. Supply chain modeling has also been done to establish optimal supply chain configuration for the transportation of feedstocks, delivery of products, etc. While informative, these models often times lack the ability to assess the long-term viability of the supply chain and do not adequately represent the uncertainty inherent to biomass-based feedstock and energy markets. A much better perspective can be gained by dynamically modeling the long-term performance of the optimal supply chain configuration determined through mixed integer linear programming with input from chemical process optimization.

This poster describes a discrete event simulation model created to combine inputs generated from independent process simulation and supply chain optimization models. Supply chain uncertainty is captured with the use of historically based probability distributions for biomass supply generation and fuel product demand. Economic performance of the supply chain is evaluated through the net present value generated. A case study supply chain for the Jackson Purchase Region of Kentucky (USA) demonstrates the usefulness of the model. Key generalizable insights into the nature of the supply chain are revealed which provide valuable information for improving biorefinery supply chain design. Benefits gained through simulation modeling are demonstrated and future applications and potential expansions of the model to encompass triple bottom line metrics are described.

Integration of Iron Nanoparticles in Functionalized Microfiltration Membranes for Toxic Metal Removal

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Selenium is a trace element that is found in the waste from the production of many electronic devices as well as coal fired power plants, mining operations and agricultural drainage. It poses an environmental danger as it is considered toxic at levels over 50ppb. In order to prevent the poisoning of ground water, it has been found that by using a treatment of iron nanoparticles, selenium can be reduced from its toxic forms as well as captured. However, treatment with suspended iron particles leads to large losses of iron. The synthesis of iron particles in a polymer hydrogel matrix (polyacrylic acid) offers the ability to capture toxic selenium without the significant loss of iron. In addition, supporting this hydrogel in a microfiltration membrane (polyvinylidene fluoride) provides a reliable platform with numerous applications in toxic metal removal. The membranes not only immobilize and prevent aggregation of the nanoparticles, but also offer convective flow operation, low iron loss, and possibilities of regeneration and clean disposal.

In Vitro Starch Catabolism, a Novel, Environmentally Safe Means of Starch Processing

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Starches are biologically available materials that are utilized for feedstocks in many industrial processes. However, they are often modified to attain desired biophysical properties. Current methods of starch modification implement harsh chemicals and present environmental concerns. Alternatively, starch derivatives can also be prepared through genetic modification of economically viable organisms. Compared to chemical modification, genetic modification is less toxic to the environment and in time could prove more economical and versatile. Organisms use metabolic enzymes (proteins) to modify starches naturally. Our lab identified two genes that encode for proteins involved in starch metabolism. These genes are categorized as glucan phosphatases; they remove phosphate groups from sugars. Modifying the sequences of either gene alters starch granule size within organisms. Eight orthologs (same gene different species) of the genes encoding the glucan phosphatases were cloned. Five of these genes were expressed as proteins and then purified. All five purified proteins underwent assays to determine how well they remove phosphate groups (phosphatase activity). Two of these proteins were further characterized for glucan binding activity. We then compared the activities of the orthologous proteins over a range of pH values. Our lab plans on using this information to further optimize in vitro starch catabolism

Compost Bedded Pack Dairy Barns: An Alternative Nutrient Management Strategy & Organic Based Fertilizer

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Nutrient management is at the forefront of environmental issues associated with animal feeding operations. Recent growth in the number of Compost Bedded Pack Dairy Barns indicates the need to evaluate these systems as a potentially more sustainable alternative to traditional nutrient management. Theoretically, Compost Bedded Pack Dairy Barns reduce input costs to producers, mitigate the risk of environmental pollution as it relates to animal waste, and offers the industry an organic based fertilizer. As a result, producers can supplement input costs to production, reduce the risk of environmental pollution, and improve overall pasture and field health. The goal of this study was to assess the fertility of the bedding as it relates to strata and particle size. Samples were collected from a cooperating dairy farmer's barn and analyzed for nutrients after performing an anaerobic digestion. Samples were tested for orthophosphate, nitrate, and ammonium. To assess the "quality and value" of the compost material, comparisons were made to Louisville Green, a commercial organic based fertilizer. Preliminary trials suggest that the loci of the compost within the pack and particle size affect its nutritional value. We conclude that bed management strategies affect the quality of the compost in the barns, and this emphasizes the need to create best management practices for producers as this system continues to expand across dairies of the Southern Region. Such a system has potential to contribute to the sustainability of the dairy industry.

Distinguishing Indigenous Phosphorus Effects on Soil and Water Quality in the Inner and Outer Bluegrass of Kentucky

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The addition of organic phosphorus (P) is necessary for sustainable productivity of cropping systems. The soils of Inner and Outer Bluegrass regions of Kentucky formed from Ordovician phosphatic limestones resulting in naturally high inorganic P levels. Because soils have a finite P sorption capacity the addition of organic P amendments in agricultural systems increases concerns about P enrichment of water resources. Characterization of 32 soils in the Inner and Outer Bluegrass regions showed similarities between the regions in terms of particle size, pH, CEC, and base saturation, but considerable differences in mineralogy and orthophosphate levels. Differences in the regional geology impart different inherent mineral characteristics that contribute to higher extractable P levels for certain soils. Mineralogical characterizations with XRD and TG analyses of the clay fraction suggested HIV, mica, kaolinite, and quartz as dominant minerals in both regions. However, unique to the Inner Bluegrass was the presence of apatite and Mn-phosphate mineral phases. Soil solutions extracted by high speed centrifugation from in situ soil samples showed surface horizon concentrations of water soluble inorganic P to be significantly higher for Inner Bluegrass soils. A 30 day aerobic incubation of organic P amended soils will be used to assess the impact of organic P amendments on soil solution and mineralogy changes via the Visual MINTEQ equilibrium speciation program. Understanding how indigenous P mineral solubility is affected by organic P amendments will improve estimations of potential P release into solution and help develop proper management strategies to alleviate impacts on water quality.

Differences in Spatial Access to Pediatric Primary Care Services among Impoverished Urban and Suburban Communities, Jefferson County, Kentucky

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Spatial accessibility of healthcare has been recognized as a problem for the urban poor for some time, however little research has been conducted on the spatial accessibility of healthcare for the suburban poor. In recent years, most techniques developed to estimate spatial accessibility have not taken into account both transportation times and the spatially distributed service capacity of providers. Through this study, I have developed a method to calculate a relative estimate of spatial accessibility that accounts for both public and private transportation and the spatial distribution of a service provider's capacity for service. My study has shown that, within Jefferson County, pediatric primary care services are significantly less accessible by both public and private transportation to large populations of poverty in the suburbs when compared to similar populations in urban areas. However, additional study-area-specific research utilizing qualitative methods is needed to further understand health care access patterns, to properly ascertain the impact that access to a private vehicle has on these patterns, and to further validate the findings of the model when incorporating private transportation as a variable.

Extending Sus-VSM and Using Simulation for Improving Sustainable Supply Chain Networks

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Value Stream Mapping (VSM) is a standard Lean tool used to analyze the flow of a product through a system. Sustainable Value Stream Mapping (Sus-VSM) builds upon traditional VSM to capture additional sustainability aspects of the product flow, such as environmental and societal aspects. This poster will present research to expand the utility of VSM and Sus-VSM and apply it to supply chain networks. The selected metrics highlight the triple bottom line of sustainability, economic, environmental, and societal, for supply chain networks while maintaining congruency with the process level Sus-VSM when feasible. Visuals for the supply chain Sus-VSM allow information to be readily available to the user and allow identification of locations where sustainability can be improved. The metrics and visuals in the supply chain Sus-VSM presented in this poster allows quick overview and analysis of the sustainability of the supply chain, resulting in better decision-making.

Future work not presented in this poster involves the use of discrete event simulation (DES) to create a model that can aid in evaluating the sustainability of various supply chain scenarios and comparing these possible future states. If insufficient data is available at a location in the supply chain, the proposed DES would also allow missing data in current and future state maps to be filled in via simulation so as to provide a more accurate portrayal of the supply chain. Overall, this research seeks to provide an extended value stream map that can capture the sustainability of a supply chain and allow for more effective analysis and improved decision-making.

How do Sundews get their Grub? A study in attraction for a carnivorous plant.

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According to Juniper et al. (1989), to be carnivorous a plant must have all components of the "carnivorous syndrome". These are: (1) attraction of prey by optical signals, scents or nectar, (2) retention of prey by traps, (3) degradation by digestive enzymes, and (4) uptake of soluble compounds. However sundews (Drosera), which comprise 30% of all carnivorous plants, have unknown mechanisms for attraction. In our study we took a novel approach and hypothesized that sundews do not attract insects, rather their sticky mucilage serves as a neutral trap similar to spider webs.

Our study involved field and lab experiments of Drosera brevifolia comparing their capture rates with a corresponding null sticky trap to test if sundews were exhibiting an attraction cue. Results showed no difference between capture rates, supporting our hypothesis that D. brevifolia is a neutral trap. Our findings suggest that while sundews are carnivorous, they do not utilize a mechanism for attracting prey. If neutral attraction is characteristic of sundews, then the carnivorous syndrome needs to be redefined.

Our study leads to more questions of Drosera life history. Sundews are very threatened and their conservation depends on answering such questions. Future directions will include more intensive testing of the hypothesis that sundews are reflective of spider webs, where the geometry of the trap determines success.

Sediment response to extreme hydrologic events in small disturbed watersheds: Implications for climate change

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Forecasted changes in climate are expected to impact the regional frequency and magnitude of extreme storm events. The potential impact of these extreme events may be especially pronounced in small tributary systems, which can be easily overwhelmed, specifically those impacted by development and ongoing land use change. This study examined the sediment transport behavior within both urban and agricultural low gradient watersheds in a representative temperate climate. Understanding the mechanisms and contributing processes of the behavior, specifically during extreme events, has implications for carbon and nutrient cycling in down-gradient stream beds due to the interactions of biogeochemical processes within the stream.

Field samples were collected to measure suspended sediment concentration of stream water at locations in the South Elkhorn Creek in the Bluegrass region of Kentucky, including one small agriculture stream and one small urban stream (watershed area=1 km2 each). An extreme event was captured at both of these sites, and the resulting data analyzed over the same time scale to understand the sediment response. Sediment flux sourcing was achieved using the concentration and flow data, as well as field investigation. The results provide a basis for future research into the role of small tributaries in larger regional terrestrial carbon budgeting.

Dynamic surface water-groundwater interactions in a tidally influenced river (Christina River Basin Critical Zone Observatory, Delaware, USA)

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Tides cause dynamic changes in river and groundwater flow in costal riparian zones. The timing of maximum groundwater discharge with respect to river discharge can impact export of nutrients and contaminants from watersheds to oceans. We investigated the effect of tidal fluctuations on groundwater discharge to White Clay Creek, located in the Cristina River Basin (Delaware, USA), one of six NSF-funded critical zone observatories. Groundwater discharge was determined using hydraulic head values from shallow water table wells in the riparian aquifer. Discharge and velocity of the river were recorded with an acoustic doppler current profiler. Preliminary results show at low tide, groundwater recharges the stream. At high tide, the hydraulic gradient reverses and river water recharges the aquifer. The tidal bank storage effect may influence nutrient cycling and contaminant attenuation. Future studies will characterize how nutrient cycling is influenced in the riparian zone of tidal rivers . A better understanding of surface water-groundwater exchange and nutrient cycling in tidally influenced rivers can inform management decisions for coastal watersheds.

Grass-fungal endophyte symbiosis: Effects on nitrogen fixation and dynamics in a Kentucky pasture.

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Tall fescue, an important forage species of pastures in the eastern U.S., can associate with an endophytic fungus, Neotyphodium coenophialum. However, endophyte presence in tall fescue can negatively impact animal production through production of toxic alkaloids; therefore, non-toxic 'novel' strains of the endophyte are being adopted by forage producers. In this study, the impact of grass: endophyte symbiosis on nitrogen fixation and dynamics was investigated by measuring 15N natural abundance in plant and soil samples. The study site consisted of tall fescue that was either infected with the common toxic strain of the endophyte, infected with one of two non-toxic strains, endophyte-free, or contained an equal mixture of endophyte treatments. To assess the effect of endophyte presence and strain on the amount of nitrogen derived from biological fixation via legume symbiosis and nitrogen use in co-occurring tall fescue, δ15N natural abundance was measured in red clover (RC), tall fescue associated with red clover (TF+RC), and tall fescue not associated with clover (TF-RC) collected from plots of each of the tall fescue – endophyte treatments. In addition, δ15N natural abundance was measured in bulk soil samples from each plot over a period of 3 years in order to gain insight into long-term changes in N-cycling in this system. Differing endophyte effects influenced δ15N in both tall fescue samples and red clover, but not in soil over time. The results of this study indicate that endophyte infection and strain have varying effects on nitrogen dynamics in both tall fescue and neighboring red clover.

Measuring the Effectiveness of Sustainability Education Efforts

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As sustainability education has gained traction, the creation of sustainability curricula and courses at the post-secondary level has increased across the globe. However, as we draw near the end of the Decade of Education for Sustainable Development, key questions still loom about how we should approach sustainability curricula at the post-secondary level. A universal design for sustainability education at the post-secondary is lacking in (1) curricular scope, (2) curricular implementation, and (3) assessment of curricular effectiveness. However, a universal design for post-secondary sustainability education will likely remain elusive in the aspects of curricular scope and implementation. For instance, differences in post-secondary faculty and administrative structures alone will no doubt lead to vast distinctions in sustainability education curricular scope and implementation. We are left still missing a key component of sustainability education design, however: assessment of curricular effectiveness. However, what assessments for curricular effectiveness in sustainability education are necessary and important for post-secondary institutions? This poster explores three common themes presented across the literature for assessment in sustainability education: the transdisciplinary nature of sustainability, the ethical responsibility for sustainability, and sustainability engagement. A theoretical framework for assessing sustainability engagement will also be presented as well as a model for assessment.

Estimating toxicity and bioavailability of pristine and aged silver nanoparticles to soil nematode Caenorhabditis elegans

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There are >2000 consumer products containing manufactured nanoparticles (NPs) available today. Experimental evidence indicates that NPs enter terrestrial environments through waste water streams and application of the resulting biosolids to soils. One of the NPs of major concern is silver nanoparticles (AgNPs), which during wastewater treatment can undergo transformations (aging) resulting in sulfidized AgNPs. We aim to understand the toxicity and bioavailability of pristine polyvinylpyrrolidone coated AgNPs (pAgNP) and fully sulfidized AgNPs (aAgNP) to Caenorhabditis elegans and to identify the most sensitive endpoint. Since AgNP toxicity can also be determined by the release of ions (Ag^+), our objective is also to differentiate between particle and ion-specific toxicity. Therefore, we included $AgNO_3$ as an additional treatment. Our results showed that pAgNP are more toxic to C. elegans than aAgNP, due in part to their higher solubility and bioavailability as evidenced by synchrotron-based x-ray microscopy. Evidence suggests that the observed toxicity is partially particle specific for AgNPs because nematodes exposed to particle free supernatants showed lower mortality. Three ecologically relevant endpoints were chosen: mortality, growth, and reproduction. For all endpoints, Ag^+ was the most toxic, and among AgNPs, the pAgNP were more toxic than aAgNP. The LC_{50} for Ag^+, pAgNP, and aAgNP were 70 µg/L, 3500 µg/L, and >10,000 µg/L, respectively. Reproduction was the most sensitive endpoint with an EC_{50} for Ag^+, pAgNP, and aAgNP at 20 µg/L, 750 µg/L, and >5,000 µg/L, respectively. Thus, aging of Ag NPs after their release into the environment can greatly modify their toxicity and bioavailability.

Enhancing Nitrogen-Use Efficiency in Winter Wheat to Combat Heat Stress Caused by Climate Change

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Triticuum aestivum (winter wheat) is an important component of the national and global food supply. However, productivity of wheat and other crops worldwide are being threatened by rising temperatures caused by global climate change. In wheat, temperatures greater than 14^{0}C stress the crop, causing its photosynthesis rate to decrease. As a result, remobilized stem reserves are used as a source for grain filling. Therefore, plants that have high nitrogen-use efficiency (NUE) under a variety of nitrogen (N) environments may be better adapted to heat stress. A replicated hill plot preliminary study was planted in Lexington, KY under three N environments (0 kg N ha^(-1), 90 kg N ha^(-1) N, 150 kg N ha^(-1)). The study was comprised of eight genotypes. Staggered planting dates of the genotypes simulated temperature increases caused by climate change. NUE will be calculated for each genotype and will be compared to temperature data collected at the study site. The goals of this study were to identify genotypes that have good NUE under different N and temperature environments, determine how heat stress affects NUE under different N environments, and estimate NUE variation among the genotypes. Also, a 320 entry NAM soft winter wheat panel was grown in five 8x8 blocks as an unreplicated augmented design in Lexington, KY. CSR measurements were taken using the JAZ instrument to estimate N status of each entry. N content collected from flag leaves at anthesis and maturity from each entry were compared to the CSR measurements to determine the adequacy of the JAZ device. The goal of the study was to determine whether canopy spectral reflectance (CSR) can be used to predict N status. However, it was found that there was no significant correlation between flag leaf N content and the CSR data.

GxExM: Variety Specific Management in Kentucky Wheat

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The complex interaction of genotype x environment x management (GxExM) that defines crop yield is often only explored with research on a single genotype or a select few genotypes. Improvements in crop management and understanding local adaptation to climate variability will require a broader understanding of specific genotype interactions with management systems across multiple environments. A multi-year study investigating the potential for variety specific management systems based on phenotypic characters in Kentucky soft red winter wheat (Triticum aestivum) was initiated in the 2012-2013 growing season. A randomized split plot design was replicated 3 times at the University of Kentucky Spindletop Research Farm in Lexington, KY. The field study evaluated 10 genotypes under 3 management systems across 4 nitrogen rates. Extensive sampling included: kernel growth rate, soil nitrate analysis, vegetative tissue and grain nitrogen analysis, relative water content, phenology, lodging and disease observations. Data collection was determined as input for DSSAT crop model for use with implementing climate scenarios on specific wheat genotypes. Initial data analysis displays genotype specific response to management systems. Results from this study will ideally bring insight into genotype x management interactions, opportunities to screen for selection with management in breeding programs, and provide a regionally specific data base for crop model simulations in variable climates.

Pore Space and Concretion Distribution in a Prairie Mound Fragipan

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Prairie mounds are unique soil landscape features distributed across the Arkansas River Valley in eastern Oklahoma and western Arkansas. Mounds in this area can be as large as one-meter in height and fifteen to thirty meters in diameter. They commonly have a fragipan below an overthickened A horizon and above a lithologic discontinuity between loess and fine-textured alluvium or residuum. A study of the characteristics of these fragipans could lend interesting insights into prairie mound genesis. A mound was bisected and the exposed mound-center profile was described and sampled according to standard methods. Intact peds from the Bx1 (Db = 1.79 g cm-3) and Bx2 (Db = 1.77 g cm-3) were analyzed for bulk density using a 3D laser scanner. Concretion content as well as abundance of vesicular, vugh and interconnected pore space as evaluated using X-ray computed tomography (CT) will be discussed.

Effect of spoil type on reforestation success, water chemistry, and hydrologic function on a mountaintop removal site in Pike County, Kentucky

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Mountaintop removal mining has altered a vast land area in Appalachia. This controversial mining practice eliminates highly biodiverse native forest cover, permanently alters topography, and is often blamed as the cause of a suite of negative environmental impacts. Restoration of mined land, thus, should be a major regional objective. Many conventional reclamation practices develop mined land into a fescue/legume dominated grassland system; however, it has been speculated that restoration to a forest system has greater potential to mitigate adverse environmental impacts of mining. A series of experimental plots was installed in 2005 on a reclaimed mine site in eastern Kentucky to examine the influence of spoil type (gray sandstone, brown sandstone, mixed sandstone/shale) on reforestation success and water quality and quantity. Two years after installation, researchers concluded that brown spoil provided the best medium for tree growth and also discharged water with the lowest concentrations of dissolved constituents. Hydrological function did not differ significant among spoil types. In 2013, tree volume is significantly higher in brown spoil than mixed, and higher in both brown and mixed than gray ($p < 0.05$). Relative volume of water discharged from brown sandstone plots is much lower than gray and mixed during the growing season, suggesting a strong evapotranspiration effect. Finally, overall water chemistry appears to have stabilized across plots, and may still be lower in brown spoil. According to these observations, when topsoil substitutes must be used, brown weathered sandstone should be used in place of gray sandstones and mixed spoil for reforestation.

Investigating abiotic and biotic factors contributing to the invasive success of Euonymus fortunei (Celastraceae) in Central Kentucky

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Euonymus fortunei (Turcz.) Hand.-Mazz. (common names: purple wintercreeper, climbing euonymus) is an evergreen liana introduced to North America from China in 1907 as an ornamental groundcover. In recent decades it has become increasingly prolific in central Kentucky forests, in many instances attaining 100% vegetative ground cover. As a juvenile vine, E. fortunei spreads horizontally to form a dense carpet of foliage that suppresses native vegetation through soil modification and resource competition. Adult maturation yields tree-supported vertical growth followed by flower and fruit production. Perhaps due to the contemporary and seemingly intermittent invasions of North America, very little information has been published in regard to the biology and ecology of E. fortunei. By addressing pertinent factors that could help to elucidate the invasive success of E. fortunei, such as seed biology, soil physical and chemical characteristics, and plant community feedback, we seek to gain greater insight into wintercreeper invasion. This presentation will outline several initial directions for our experimental work on E. fortunei, discussed in the context of what is currently known about the life history of this species. These data will serve as a foundation for future experiments, and contribute to the knowledge base crucial for wintercreeper eradication and prevention efforts.

Antibiotic Transport from plots treated with swine manure

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Antibiotics are commonly used in animal agriculture to treat and prevent diseases, as well as promote growth. Unfortunately, large amounts of antibiotics are not metabolized, but instead are excreted in urine and feces. Manure, along with the antibiotics it contains, is then land applied as a source of nutrients for crops and pastureland. Antibiotics then have the potential be transported to surface waters via runoff after large storm events. The potential of one broad spectrum antibiotic (Oxytetracycline) to be transported in runoff was evaluated in this study. Simulated rainfall experiments were conducted on fescue plots during July and August of 2013 at the University of Kentucky's Spindletop Research Farm. The fescue plots were given one of four treatments: manure only, manure + oxytetracyline, manure + oxytetratcyline + alum or nothing applied (control). Runoff samples were collected at various times during the simulated storm and analyzed for oxytetracycline, NO_2-N, NO_3-N, NH_4-N, PO_4-P, pH, EC, TSS, Cl, and TOC. A flow-weighted composite was also created and analyzed.

Hydrologic Characterization of a Rain Garden Mitigating Stormwater Runoff from a Commercial Area

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Impervious surfaces such as roads, sidewalks, and roofs increase the volume of runoff generated in a watershed. Traditional stormwater management techniques emphasize conveyance of runoff away from impervious surfaces. Rain gardens are becoming popular as a different means to manage stormwater in such a way that runoff is captured and infiltrated onsite rather than conveyed offsite. A series of stormwater management controls consisting of a rainwater harvest system, rain garden, and infiltration chamber was built at the Coca-Cola Refreshments USA, Inc. distribution center in Lexington, Kentucky during the fall of 2011. Precipitation, inflow, and water level were measured from May, 2012 to April, 2013 to evaluate the hydrologic performance of the rain garden. The rain garden had a high infiltrative capability and was able to capture and infiltrate 100% of the runoff generated during the study period. The results of the study were used to formulate recommendations for rain garden design and construction in central Kentucky.

Variation in Surface Soil Carbon Distribution Across Forested and Grassed Loess Catenas in the Shawnee Hills

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Surface soil carbon, a significant fraction of total soil carbon, is sensitive to environmental changes and land use. This work considers soil carbon volumes as comparators of management and environmental effects on three matched (forest and grasslands) pairs of managed zero order watersheds as a part of watershed-based soil landscape study in the Shawnee Hills region of Illinois, Indiana, and Kentucky, located within USDA NRCS Major Land Resource Area 120 (Kentucky and Indiana Sandstone and Shale Hills and Valleys). The six watersheds comprising the sample area of the Shawnee Hills Loess Catenas Project share parent materials and land use characteristics thus creating a unique opportunity to study interactions of soil landscape positions (summit, shoulder, backslope, footslope, toeslope) with management practices on a watershed scale. To this end, landscape positions were delineated within each watershed. Soil surface bulk densities (1-7cm) and total carbon (by dry combustion method) were determined for each of duplicate soil cores collected at a minimum of ten randomly generated points within each landscape position. Carbon distribution was evaluated as a function of parent material (random effect of watershed pair location), space (within and among points, and within and among landscape positions), and land management (forest or grassland). Carbon distribution varies with thickness of the parent material loess deposit in a complex fashion. Volumetric carbon variance is heterogeneous, and increases as a monotonic function with decreasing thickness of loess deposit. Landscape positional effects are evident when loess deposit is thin.

Augmenting Renewable Energy Output of Workout Equipment by Changing User Behavior

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Electricity needs have increased dramatically in the United States, most of which is produced by burning coal, releasing carbon dioxide in amounts never-before-seen in human history. Initiatives using more sustainable energy are being adopted by U.S. institutions and many others around the world. Fitness centers are no exception. One strategy involves harnessing energy produced during workouts and encouraging patrons to use exercise machines that create electricity. However, high start-up costs associated with these programs makes their success highly dependent on a reasonable payback period. This study analyzes user behavior at the University of Kentucky Johnson Recreation Center from August 2011 thru May 2013. The goal is to identify factors contributing to differences in electricity outputs in an effort to understand workout behavior and to make a more reasonable payback period for aforementioned programs. During the study, a promotional campaign, Burn to Earn, encouraged the usage of 16 Precor elliptical machines retrofitted with ReRev technology, enabling kinetic energy conversion into electricity. This campaign hopes to achieve a more reasonable payback period. Results indicate that the Burn to Earn program was successful in increasing usage of the Precor elliptical machines, mostly by users substituting away from their normal exercise equipment. These findings can be used to help determine how to make renewable sources similar to ReRev more cost-effective and have a shorter payback period through behavioral and cultural changes of users.