COVER SHEET FOR GRANT PROPOSALS
State Board of Education

SBOE PROPOSAL NUMBER: (to be assigned by SBOE)	AMOUNT REQUESTED: $75,000

TITLE OF PROPOSED PROJECT:
N-E-W Terra™: An Enhanced Efficiency Fertilizer (EEF) Manufactured from Biochar

SPECIFIC PROJECT FOCUS:
The Project Objective is to successfully filter and harvest N-E-W Terra™ enhanced efficiency fertilizer from our 2013 patent-pending wastewater treatment process N-E-W Tech™ and to use our UI Office of Technology Transfer disclosed new technology: "N-E-W Terra™: A System and Process for Manufacture of an Enhanced Efficiency Fertilizer" in horticultural studies and in advanced soil, water, plant research to determine efficacy, engineering economics, scale-up potential and market potential.

PROJECT START DATE: July 1, 2015	PROJECT END DATE: June 30, 2016
NAME OF INSTITUTION: University of Idaho	DEPARTMENT: Plant, Soil and Entomological Sciences
ADDRESS: PO Box 442339, Moscow, Idaho	
E-MAIL ADDRESS: dgstrawn@uidaho.edu	PHONE NUMBER: 208-885-2713

	NAME:	TITLE:	SIGNATURE:
PROJECT DIRECTOR/PRINCIPAL INVESTIGATOR	Daniel G. Strawn	Professor	
CO-PRINCIPAL INVESTIGATOR	Greg Moller Robert Tripepi	Professor Professor	

NAME OF PARTNERING COMPANY: J.R. Simplot Company	COMPANY REPRESENTATIVE NAME: Terry Tindall, Director of Agronomy

	NAME:	SIGNATURE:
Authorized Organizational Representative	Dr. John McIver Vice President ORED	6-26-15

SUMMARY PROPOSAL BUDGET

Name of Institution :University of Idaho

Name of Project Director: Daniel G. Strawn

A. PERSONNEL COST (Faculty, Staff, Visiting Professors, Post-Doctoral Associates, Graduate/Undergraduate Students, Other)

Name/ Title	Salary/Rate of Pay	Fringe	Dollar Amount Requested
Unnamed, Research support Scientists	$25/hr	39.2%	7000
Strawn, Professor	$50/hr	31.6%	5300
Unnamed, Strawn Intern	$12.50/hr	2.5%	3200
Unnamed, Tripepi Intern	$12.50/hr	2.5%	4500
Unnamed, Moller Intern	$12.50/hr	2.5%	3200

% OF TOTAL BUDGET:	31	SUBTOTAL:	23200

B. EQUIPMENT: (List each item with a cost in excess of $1000.00.)

Item/Description	Dollar Amount Requested
Biochar	1600
Tequatic Plus 35 (30 micron)	10000
SUBTOTAL:	11600

C. TRAVEL:

Dates of Travel (from/to)	No. of Persons	Total Days	Transportation	Lodging	Per Diem	Dollar Amount Requested
Sept. 2015 from Moscow to Twin Falls	2	4	900	800	300	2000
June 2016 from Moscow to Boise	2	3	500	520	180	1200
SUBTOTAL:						3200

D. Participant Support Costs:

	Dollar Amount Requested
1. Stipends	
2. Other	
SUBTOTAL:	0

E. Other Direct Costs:		Dollar Amount Requested
1. Materials and Supplies		5000
2. Publication Costs/Page Charges		
3. Consultant Services (Include Travel Expenses)		
4. Computer Services		
5. Subcontracts		
6. Other (specify nature & breakdown if over $1000) Analytical cost for characterization (chemical, microbial, physical) Greenhouse rental and supplies Shop Fabrication	 20000 6000 5500	32000
	SUBTOTAL:	37000
F.. Total Costs: (Add subtotals, sections A through E)	**TOTAL:**	75000
G.. Amount Requested:	**TOTAL:**	75000
Project Director's Signature: 		Date: June 26, 2015

INSTITUTIONAL AND OTHER SECTOR SUPPORT

(add additional pages as necessary)

A. INSTITUTIONAL / OTHER SECTOR DOLLARS

Source / Description	Amount
none	

B. FACULTY / STAFF POSITIONS

Description

none

C. CAPITAL EQUIPMENT

The N-E-W Tech™ reactor assembly valued at $150,000 will be used to produce nutrient-enhanced biochar. A truck valued at $34,000 will be used to tow the reactor assembly to high nutrient water field sites. A provisional enhanced efficiency biochar fertilizer reactor prototype valued at $8,000 will be used to support the research. FTIR Spectrophotometer valued at $80,000 will be for molecular characterization.

D. FACILITIES & INSTRUMENTATION (Description)

none

1. Name of Idaho public institution: University of Idaho

2. Name of faculty member directing project: Daniel G. Strawn

3. Indicate if this technology been proposed and/or been awarded an Incubation Fund Award in the past: This project has not received an Incubation Fund Award in the past.

4. Executive Summary: In this work we propose to partner with the J. R. Simplot Company to advance N-E-W Terra™, a University of Idaho proprietary process Enhanced Efficiency Fertilizer (EEF) that incorporates biochar that is chemically activated by nutrient nitrogen (N) and phosphorus (P). The Fertilizer Institute defines EEFs as: "fertilizer products that can reduce nutrient losses to the environment while increasing nutrient availability for the plant or the crop." N-E-W Terra™ is an engineered next-generation EEF. The core of our newly developed technology uses biochar, a biomass energy byproduct that when amended to soils increases crop productivity, retains soil moisture, and sequesters carbon. The major project elements include: 1) engineering design of a nutrient activated biochar reactor and material transfer unit operation; 2) molecular studies to determine the physico-chemical changes and controls in nutrient augmented biochar, and 3) horticultural studies to explore the plant growth response to a range of N-E-W Terra™ substrates produced in this project.

5. "Gap" Project Objective and Amount Requested: We are requesting $75,000 to support this project. The Project Objective is to mechanically separate N-E-W Terra™ enhanced efficiency fertilizer from our 2013 patent-pending wastewater treatment process N-E-W Tech™, and also to use our UI Office of Technology Transfer disclosed new technology: "N-E-W Terra™: A System and Process for Manufacture of an Enhanced Efficiency Fertilizer" in horticultural studies to determine efficacy, product optimization, and market potential. While there is ample evidence to suggest biochars are beneficial soil amendments, application of

biochar alone for agronomic benefit has not yet been realized because the benefit–cost analysis is not positive. To increase the economic benefit of biochar for soil quality and crop yield increase, biochar needs to be enhanced. Creating an enhanced efficiency fertilizer (EFF) from biochar to meet the needs of the marketplace will increase product value and address societal needs for limiting nutrient pollution in U.S. waterways and coastal regions. In this innovation project we will test how various formulations of EEF-biochar affect soil properties and plant growth. The data will be used to support the N-E-W-Terra™ product development, marketing strategy, and new scientific knowledge required for fertilizer licensing by state governments.

6. Alignment of resource commitments with priorities of the home institution: The principal investigators of this project are employees at the University of Idaho, funded via federal and state resources. These resources support facilities such as experimental green houses, laboratories and field plots, and support personnel for agricultural research. Work for this project will be conducted in the UI Moscow campus soil chemistry, horticulture, and environmental chemistry and toxicology laboratories, in addition to the 20,000 sq ft CALS Sixth Street Greenhouse.

The UI Office of Technology Transfer has six related patents issued and licensed to our water treatment partner Blue Water Technologies, Inc. of Hayden, Idaho, and one N-E-W Tech™ (Biochar Water Treatment; 84 claims) patent pending for the reactive filtration water treatment platform invented in our research (Möller and Strawn, Biochar Water Treatment, PCT Application No. PCT/US2014/066677; Pat. Pend., 11/20/2014). The proposed product development will enhance agricultural productivity and builds on our water treatment platform that advances next generation unrestricted water reuse and recycling, and in the process creates a nutrient rich byproduct that can be used as an enhanced efficiency fertilizer (N-E-W-Terra™). University of Idaho and the Idaho Department of Commerce IGEM are currently funding

development of the water treatment technology aspect of N-E-W Tech™, however funds for development and evaluation of the water treatment residual we are branding as N-E-W-Terra™ were not included. The UI "Biochar Water Treatment" patent application is now published, and the first Office Action has graded all 84 patent claims as "novel." Several of these claims address the recovery of nutrient augmented biochar from the treatment of high nutrient wastewaters. Our recent independent technology disclosure to the UI Office of Technology Transfer for direct manufacture of N-E-W-Terra™ is a principal component of the present funding request.

UI is vested in N-E-W Tech™, for example funding the 2015 purchase of a $34,000 truck to tow the N-E-W Tech™ trailer for site research around Idaho. This Innovation Fund grant will ready N-E-W-Terra™ for licensing, and capitalize on the full N-E-W Tech™ vision and potential as a technology that addresses the grand challenges of energy, water, and food security.

7. Evidence that the project will have a potential impact to the economy of Idaho: Fertilizer companies such as Idaho's J.R. Simplot Company have active wholesale and retail fertilizer market access, a global distribution network and business opportunity. Simplot's "Best" brand fertilizer addresses the needs of residential and commercial landscapers. At the residential consumer level as well as the wholesale marketplace, green and organic products, such as biochar fertilizers, are advancing in consumer attractiveness. This market dynamic was predicted in the "Going Green" article appearing in the June 2010 issue of Harvard Business Review. In the business world, the market potential for biochar is well addressed by the recent history of the 2013 start-up Cool Planet/Cool Terra biochar bioenergy company which has obtained about $200M in Series D investment funding. We are currently cooperating with Cool Planet as our raw biochar supplier in the N-E-W Tech™ water research project.

8. The Market Opportunity

a. Need the project would address: Phosphorus, primarily mined from reserves, is a limited resource required for production of food, and used in many industries; it is classified as a U.S. Strategic Mineral. Current reserve estimates suggest that continued extraction will become more costly after the next 20 years. Thus, P fertilizer price is expected to increase (in 2007 P fertilizer prices increased 700%; and have since declined to ~3× pre-2007 prices) (http://www.infomine.com/investment/metal-prices/phosphate-rock/all/). The interesting paradox with P is that while the raw resource is becoming less available, human inputs of P to the environment from agriculture run-off, domestic waste water, and industry are causing degradation of water quality because they create algae blooms that produce toxic chemicals and cause eutrophication. Agricultural use of fertilizers is the largest non-point nutrient source, and technology is needed to help reduce off-site fertilizer mobility. This requires new fertilizers that will make nutrients available to the plant, but not available for leaching. N-E-W Tech™ is a process that provides cutting-edge treatment of waste water to reduce nutrient content using an energy production byproduct. The biochar residual will be loaded with nutrients, and is an enhanced efficiency fertilizer sourced from a renewable resource. Recovery of the P will decrease demand for mining the rock P, and simultaneously decrease P loss to the environment and create a new product.

Of the total amount of phosphorus mined and used in agriculture, only 20% actually ends up in food (Schroeder et al. 2011). Thus, there is ample opportunity to increase P use efficiency. N-E-W Tech™ and N-E-W Terra™ are technologies that will address this market sector, satisfying increasing pressure for sustainable resource use. In the past decade, major initiatives have been started to explore the challenge of closing the phosphors cycle (*European Sustainable Phosphorus Platform* http://phosphorusplatform.eu/ , and a United States effort called *Sustainable Phosphorus Initiative* https://sustainablep.asu.edu/). N-E-W Tech™ and N-E-W

Terra™ are novel technologies that offer: 1) a new source of P for agricultural applications in light of declining reserves, 2) reduces loss of P into the environment, 3) adds value use of a waste P stream, and 4) increases crop yields to meet growing global food demands. Because of these added values, N-E-W Terra™ will compete well with current products.

b. Applications and markets for the technology (market size and demand projections):

Global demand for phosphorus is about 200 billion metric tons per year (Sustainable Phosphorus Institute: https://sustainablep.asu.edu/about). In 2012, the United States used 16 million metric tons of phosphorus for plant growth (agriculture, home, horticulture) (http://www.tfi.org/statistics/fertilizer-use). N-E-W Terra™ will be a EEF used in agriculture, nurseries, and domestic applications. As an example of the value of this market: approximate current P fertilizer prices are about $600 per metric ton (Source: Agricultural Prices, National Agricultural Statistics Service, USDA), if 0.1% market share of the US phosphorus fertilizer market can be captured by an EEF such as N-E-W Terra™, this translates to a $9.6 million market value per year (16 million tons/yr used × $600/ton × 0.001 = $9.6 million). Current estimates are for the phosphorus fertilizer market to grow by 2.5% per year (Fertilizer Outlook 2015-2019; P. Heffer and Michel Prud'homme; International Fertilizer Industry Association (IFA)). The increasing requirements for agricultural producers to decrease P leaching from soils is causing pressure to use EEFs that feed the crop, not the soil and surrounding waters. Thus, there is potential for N-E-W Terra™ to capture existing and some of the projected new market growth.

N-E-W Terra™ is built on a sustainability platform that utilizes biochar. Biochar as a soil amendment is an ancient process that gained new interests in the 21st century. As a developing product, consumer interests are somewhat ahead of research, but demand is not yet fully realized because the economic benefits have not been shown to be positive. Valuation of the biochar

markets are highly speculative, partly because the definition of biochar is not yet agreed upon. However, analysts suggest that the biochar market will see double digit annual growths over the coming decade (http://www.marketwired.com/press-release/vega-biofuels-named-key-player-in-global-biochar-market-industry-analysis-otc-pink-vgpr-1973733.htm).

The value proposition of biochar as a soil amendment to increase yield within a crop is not yet profitable. One way to increase the value of biochar is to add phosphorus and nitrogen, such as in N-E-W Terra™. N-E-W Terra™ will contain four value added benefits: 1) physical improvements to soil (e.g., water holding capacity); 2) addition of plant nutrients; 3) slow release of nutrients; and 4) addition of soil carbon, which improves soil properties such as cation exchange, in addition to its role as a carbon sink helping in the global carbon balance. The increased benefits of N-E-W Terra™ will make it attractive for the fertilizer industry exploring EEFs and the retail and wholesale marketplace.

c. Product description, audience, competition, and barriers to market entry: N-E-W-Terra™ is an enhanced efficiency fertilizer that is part of a state of the art water treatment process and renewable fuels byproduct. N-E-W-Terra™ recycles nutrients from waste waters and is a 21st century sustainable systems technology. N-E-W-Terra™ co-creates business value and social value by providing an enhanced efficiency fertilizer for agriculture, nurseries and domestic users. N-E-W-Terra™ addresses the need for enhanced agronomic applications of biochar and will minimize and mitigate nutrient impacted waterways, address the opportunity for bioenergy and carbon sequestration, and when integrated with N-E-W Tech™, recycle water resources in centralized or distributed operations.

Barriers to entry are: 1) required registration for fertilizers and soil amendments (the latter less stringent); 2) competing products exist, although none can claim the benefits of

N-E-W Terra while being developed from a sustainable nutrient recycling water treatment process; and 3) some of the benefits of EEF and biochar occur over several years, and costs analysis may not be realized directly after application, thus education of consumers is required.

9. The Technology and Path to Commercialization

a. Current state of the technology: Our N-E-W Terra™ technology augments biochar from biomass-bioenergy waste streams with nitrogen and phosphorus nutrients for enhanced crop yields, and use in landscaping and horticultural applications. We produce N-E-W Terra™ either as a water treatment residual or as a biochar fertilizer substrate *de novo* in a controlled manufacturing process. We have studied laboratory nutrient adsorption onto biochar and have ongoing efforts to demonstrate the capacity of N-E-W Tech™ water treatment to remove and potentially recycle N/P into a biochar matrix for recovery at a 15,000 gallons per day wastewater treatment rate; this corresponds to a *Technology Development Level 2*: "Emerging Technology Demonstrations or First Generation Technologies." We have disclosed the process for direct manufacture of N-E-W Terra™ to the UI Office of Technology Transfer.

b. Contribution of the product to market need and its intellectual property status: N-E-W Terra™ is an enhanced efficiency fertilizer that will directly fill the market for fertilizers and will address the global challenge of sustainable water, energy, and food production. Based on technology, patent literature and market surveys, we believe N-E-W Terra™ has both intellectual property value and market potential that will be enhanced by the proposed gap product development research. We have six of the eighty-four claims in our 2013 Biochar Water Treatment patent application related to water treatment residual fertilizer production, and all claims have been graded as novel in the first patent office action. In addition, we have disclosed a direct N-E-W Terra™ manufacture process and system to the UI Office of Technology

Transfer. We have an Idaho industry partner in both N-E-W Terra™ and N-E-W Tech™ and in June 2015 UI OTT received a venture capital firm inquiry about N-E-W Tech™.

c. Identify who developed the technology and with what funding: The product was developed by Dr. Moller and Dr. Strawn who are salaried employees of the University of Idaho using USDA Hatch Act funds.

d. Identify the concrete steps to bring technology to market:

1. Molecular characterization to better define agronomic potential.
2. Pilot scale manufacture of N-E-W Terra™ to explore the application of advanced material transfer and processing of this substrate .
3. Controlled plant growth trials to characterize agronomic value.
4. Develop product facts and characteristics document.
5. Apply for provisional patent for N-E-W Terra™.
6. Life cycle and engineering economics assessment to explore market potential.
7. Make available for licensing through UI Office of Technology Transfer.
8. Identify commercialization opportunities and potential for investment, licensing, and productization with start-up ventures, established companies, and investment community.

10. Commercialization Partners: The J. R. Simplot Company is the commercialization partner for this incubation project. We are working with Simplot executive Dr. Terry Tindall on product development and characterization. Results will be shared with project partner Dr. Tindall and monthly conference calls arranged to discuss R&D and market needs for product enhancement and characterization. Toward the end of the yearlong project, we will travel to J. R. Simplot Company headquarters to meet with Dr. Tindall and give a presentation of N-E-W Terra™ product development and make plans for the next steps in the pathway for bringing the product

to market. We will make bulk samples available to Dr. Tindall should he wish to test them in trials. When we complete product development and invention protection, Simplot can license the technology from UI Office of Technology Transfer. Currently the J. R. Simplot Company partners with UI CALS to support research field sites at the Parma Research Station in the amount of $2 million per year for product testing and agronomic trials.

11. Specific Project Plan and Detailed Use of Funds: Biochar will be modified to have increased nutrient adsorption capacity. The details of the modification are described in the 2013 patent-pending wastewater treatment process N-E-W Tech™. N-E-W Terra™ will also be produced as an enhanced efficiency fertilizer (EEF) product in a separate process from the N-E-W Tech™ filtration reactor. This includes customizing the surface properties and amount of nutrient loading. The custom modification will create a new EEF in N-E-W Terra™. We will work with our project partner Dr. Tindall at J. R. Simplot Company to tailor the product to the needs of the market and industry.

N-E-W Terra™ will be characterized for complete physical and chemical properties, including total element composition; presence of recoverable organics, including xenobiotics; surface area; porosity; hydrophobicity; available nitrogen, phosphorus, potassium and micronutrients; cation adsorption capacity; and mechanical strength. Impacts of N-E-W Terra™ to soil microbiological activity and plant growth will be measured using amended soils in a greenhouse test. Soils will be amended at rates of 1/2×, 1×, and 2× recommended P fertilizer values. Soil pH, and water holding capacity will be measured in the study. Tomato plants will be grown in the controlled greenhouse study for six to eight weeks. At harvest leaf and shoot biomass will be measured; root biomass will also be measured.

Test of N-E-W Terra™ pelletization, with and without binders, will be done to determine how the product behaves in an application-optimized form. The pellets will be mixed with soil and wetted for different times to test the physical stability and degree of integration of the N-E-W Terra™ into the soil.

Dr. Strawn will be in charge of overall project and N-E-W Terra™ chemical and physical characterization (two weeks of summer salary plus fringe ($5,300)). Dr. Möller will be in charge of N-E-W Terra™ synthesis and development, materials handling and processing unit operation development, as well as integration of N-E-W Terra™ with N-E-W Tech™. Dr. Tripepi will be in charge of the plant growth studies in the greenhouse. Two hundred hours of research associate salary plus fringe are requested to assist on the experimental aspects of the project ($7,000). Three undergraduate interns will be hired to work on the project for a total of 850 hours ($10,900). Materials, including purchase of biochar from Cool Planet Inc., supplies, and metal shop fabrication are $18,000. Analytical costs including tests for xenobiotic organic chemicals (up to $1000 per sample) will costs $20,000. A cross-flow centrifugal solids separation filter (DOW Corporation Tequatic Plus 35 (30 micron)) will be purchased to separate the biochar from suspensions ($10,000). Travel to J. R. Simplot Company to collaborate, and travel to Twin Falls to collect soils and dairy water samples in support of product testing will be done ($3,200).

12. Institutional and Other Sector Support: Project investigators Strawn, Möller and Tripepi are professors in the College of Agriculture and Life Sciences. They maintain fully equipped laboratories required for conducting experiments, including equipment for physical and chemical characterization. CALS has greenhouse space for plant growth studies. Three undergraduate interns and a staff scientists will be hired to assist in experiments.

Simplot
AGRIBUSINESS J.R. SIMPLOT COMPANY 999 MAIN STREET BOISE, IDAHO 83702

June 24, 2015

Daniel Strawn, PhD.
Professor of Environmental Soil Chemistry
University of Idaho Department of Plant, Soil, and Entomological Sciences
PO Box 442339
Moscow, Idaho 83844-2339

Dear Dr. Strawn:

The J.R. Simplot Company is a privately held multinational agribusiness company headquartered in Boise, Idaho. Simplot manufacturing in Idaho includes frozen and dehydrated potato processing, phosphate ore mining and fertilizer manufacturing, production agriculture and cattle operations. Research activities conducted by Simplot in Idaho include crop and animal genetics, grass and turf seed development, and new fertilizer technologies.
The Simplot Company agrees to be a project partner on the proposal entitled, "N-E-W Terra™: An Enhanced Efficiency Fertilizer (EEF) Manufactured from Biochar," that you, Dr. Möller and Dr. Tripepi will be submitting to the HERC Idaho Incubation Fund Program. Development of enhanced efficiency fertilizers fits well within the Simplot Company profile.

As the product research progresses, I am happy to provide industry perspective on what information and product qualities are needed for N-E-W Terra™ to transition to the next stage of product development. Such information is critical in the R&D stages of product development, and can make a difference in the direction of research and success of developing a pathway for the University of Idaho's research for companies, such as Simplot Company, to adopt new technologies.

I look forward to working with the University of Idaho group on conducting research on N-E-W Terra™. The Simplot Company and the University of Idaho have collaborated on several research ventures. The current collaboration at the Parma Research Station is just one example.

Sincerely,

Terry A. Tindall, PhD
Director of Agronomy
J.R. Simplot Company
Boise Idaho

Facilities and Equipment

The UI **Environmental Soil Chemistry Laboratory** is equipped with general wet-chemistry equipment, including pH probes, filter assemblies, deionized water, and exhaust hood. An ICP-AES for elemental determinations, pH-stat and autotitrator, FTIR spectrometer with DR, ATR and microscope accessories, colorimetric auto analyzer, total CNS combustion analysis, HPLC-MS, and ion chromatograph are available in the soil chemistry lab complex. Facilities are also available for physiochemical characterization of rock, soil, and mineral samples, including particle-size analysis, selective chemical extractions, thin section preparation, and polarized light microscopy. A controlled-atmosphere glove box is available for samples requiring anaerobic handling. A powder XRD, FE-SEM, and TEM are available in the UI Geology department. A FE-X-ray microprobe is available at Washington State University (10 miles away).

All faculty, staff, and graduate student offices are equipped with personal computers. All offices have independent hardwire and secure wireless access to 100 megabits-per second internet connections. All computers have installed software both for specialized data analysis, and word processing, spreadsheet and database functions, and graphing.

The **Environmental Chemistry and Toxicology laboratory** has a range of field and laboratory sampling devices and resources for sample preparation and characterization of macro constituents of environmental samples. The Laboratory is 1,500 ft with safety hoods, freezer, incubators, and refrigerator. The laboratory has electronic pipettes, macro and micro balances, and glassware resources. There is a separate student desk area that can accommodate six students. The lab has an array of small pumps, columns, temperature controllers, bench pH/ISE meters, mixers and electronic resources such as fast oscilloscopes. Large analytical equipment includes am Agilent 4500 ICP-MS with autosampler, and a Dionix ion chromatograph. Field

equipment includes an array of 10 gpm water pumps, field power generators (2), a field pick-up truck (2001), and reagent dosing pumps. A field laboratory converted from an air conditioned 27 ft. travel trailer is available for extended field operations.

The **Plant Physiology and Horticulture Laboratory** is fully equipped for planting and growth studies. The greenhouse complex covers 20,000 square feet, including 18 compartments comprising

- 13,000 square feet of greenhouse space
- A dozen reach-in or walk-in growth chambers comprising a total of 500 square feet
- Large head house with space for classes, work, and storage
- Dendrology collection (room 213) with over 350 species representing 55 families of plants

Greenhouse compartments and growth chambers are programmed and operated using the fully automated Argus environmental control system. Some compartments are equipped with automated misting and irrigation benches. All are equipped with lighting such as fluorescent, incandescent, high-pressure sodium, and metal halide.

The greenhouse has its own weather station that records temperatures, humidity, wind speed and direction, and photosynthetically useful sunlight. An advanced recordkeeping system permits access to historical environmental data and a comprehensive alarm system ensures a reliable growth environment in all chambers.

Biographical Sketch

Dr. Daniel G. Strawn
Professor of Soil Chemistry
Department of Plant, Soil and Entomological Sciences

Education

University of California, Davis	Soil and Water Science	B.S., 1994
University of Delaware	Soil Chemistry	Ph.D., 1999
University of California, Berkeley	Division of Ecosystem Sciences	Postdoc.1998-1999

Employment History

2011-present: Professor of Soil Chemistry, University of Idaho, Department of Plant Soil and Entomological Sciences, Division of Soil Science

2005-2011: Associate Professor of Soil Chemistry, University of Idaho, Department of Plant Soil and Entomological Sciences, Division of Soil Science

2007-2008: Visiting scientists/sabbatical appointment, Molecular Structures Division, Institute of Radiochemistry, FZD, Germany.

2000-2005: Assistant Professor of Soil Chemistry, University of Idaho, Department of Plant Soil and Entomological Sciences, Division of Soil Science

Expertise and Interests

The goal of my research program is to gain a better understanding of chemical speciation and reaction processes in the soil and environment. My research includes field and laboratory investigations in four areas:

1. chemical and mineral speciation
2. reaction processes in the environment and on mineral surfaces
3. factors that affect the fate of chemicals and minerals in the environment
4. remediation and management strategies for contaminated environments

Systems researched include soils, surface water, stream and lake sediments, and the vadose zone, as well as models of natural mineral systems. To discover speciation, I use advanced analytical methods to probe molecular and mineral structure of chemicals and minerals in natural and model system samples.

Relevant Professional Experience and Synergistic Activities

Service: Chair, Soil Chemistry section, national Soil Science Society of America; past associate editor (6 years), Soil Science Society of America

PI on grants from USDA, USGS, EPA, Idaho Dept. Env. Quality., Idaho Dept. of Commerce, Idaho Wheat Commission.

Honors and Awards

Presidential Early Career Award for Scientists and Engineers-USDA; Eddie Wastewater Principals and Processes Medal from the Water Environment Federation. Journal of Environmental Quality Reviewer Recognition Award (2005, 2010); 2011 Marion L. & Chrystie M. Jackson Soil Science Award.

Teaching

Environmental Soil Chemistry, Advanced Environmental Soil Chemistry, Soil Mineralogy, Subsurface Geochemical Processes, and Graduate Soil Seminar.

Students Mentored (Last 5 years): Major Advisor-12 MS students, 2 PhD, 1 Postdoctoral student, and 5 senior theses. Served on 20+ PhD and MS degree committees

Publications (last 5 years)

1. Strawn, D.G., A.C. Rigby, L.L. Baker, M.D. Coleman, and I. Koch. 2015. Biochar Soil Amendment Effects on Arsenic Availability to Mountain Brome (Bromus marginatus). Journal of Environmental Quality, *in press*.
2. Osborne, L.R., L.L. Baker, and **D.G. Strawn**. 2015. Lead Immobilization and Phosphorus Availability in Phosphate-Amended, Mine-Contaminated Soils. Journal of Environ Quality 44:183-190.
3. Baker L.L. and **Strawn D.G.** 2014. Temperature effects on synthetic nontronite crystallinity and implications for nontronite formation in Columbia River Basalts. Clays and Clay Minerals, 62:2, 89-101.
4. Baker L.L., Nickerson R.D. and **Strawn D.G.** 2014. XAFS study of iron-substituted allophane and imogolite. Clays and Clay Minerals, 62: 1, 20-34.
5. Ippolito, J.A., **D.G. Strawn**, and K.G. Scheckel. 2013. Investigation of Copper Sorption by Sugar Beet Processing Lime Waste. Journal of Environ Quality, 42:919-924.
6. **Strawn, D.G.**, P.J. Hickey, P.A. McDaniel, and L.L. Baker. 2012. Distribution of As, Cd, Pb, and Zn in redox features of mine-waste impacted wetland soils. *Journal of Soils and Sediments* 12:1100-1110.
7. Baker, L., and **D.G. Strawn**. 2012. Fe K-edge XAFS spectra of phyllosilicates of varying crystallinity. *Physics and Chemistry of Minerals* 39:675-684.
8. Baker, L.L., W.R. Rember, K.F. Sprenke, and **D.G. Strawn**. 2012. Celadonite in continental flood basalts of the Columbia River group. *American Mineralogist* 97, pages 1284–1290.
9. Ippolito, J. A., **D. G. Strawn**, K. G. Scheckel, J. M. Novak, M. Ahmedna, and M. A. S. Niandou. In press, 2012. Macroscopic and Molecular Investigations of Copper Sorption by a Steam-Activated Biochar. *Journal of Environmental Quality* 41:1150-1156.
10. Oram L., **D. G. Strawn**,G. Möller. 2011. Chemical Speciation and Bioavailability of Selenium in the Rhizosphere of Symphyotrichum eatonii from Reclaimed Mine Soils. *Environmental Science & Technology.* 45:870-875.
11. Baker, L., **D.G. Strawn**, W. Rembre, K. Sprenke. 2011. Metal content of charcoal in mining-impacted wetland sediments. *Science of the Total Environment.* 409: 588-594.
12. Baker, L**. D.G. Strawn**, P. McDaniel, K. Vaughn. 2010 . XAS study of Fe mineralogy in a chronosequence of soil clays formed on basaltic cinders. *Clays and Clay Minerals*. 6:772-782.
13. Oram L., **D. G. Strawn**, M. Morra, G. Möller. 2010. Selenium Biogeochemical Cycling and Fluxes in the Hyporheic Zone of a Mining-Impacted Stream. *Environmental Science & Technology*. 44: 4176–4183.
14. Baker, L., **D.G. Strawn**. R. Smith. 2010. Cation Exchange on Vadose Zone Research Park Subsurface Sediment, Idaho National Laboratory. *Vadose Zone Journal*. 9: 476-4

BIOGRAPHICAL SKETCH

NAME	POSITION TITLE
Möller, Gregory	Professor of Environmental Chemistry and Toxicology
eRA COMMONS USER NAME (credential, e.g., agency login) gmoller	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
Wichita State University, Wichita, KS	BS	1977	Honors Chemistry
University of California, Davis, CA	PhD	1985	Physical Chemistry

A. Positions and Honors

2008-present, Professor of Environmental Chemistry and Toxicology (tenured) – UI-WSU School of Food Science and UI Environmental Science Program; Adjunct Faculty - Department of Chemical Engineering. (40% teaching, 60% research).

2002-2008, Associate Professor of Environmental Chemistry and Toxicology (tenured) - Department of Food Science and Toxicology and Environmental Science Program; Adjunct Faculty - Department of Chemical Engineering. (2002-2006: 10% teaching, 20% research, 70% service; 2006-2008: 40% teaching, 60% research).

2005 (January-July) Fulbright Fellow, Greece – Lecturing and Research (Water Quality), Environmental Studies Department, University of the Aegean, Lesvos Island, Greece. Scholar in Residence: Agricultural University of Athens, University of Crete, Technical University of Crete, Aristotle University, University of Macedonia.

1995-2002, Assistant Professor of Environmental Chemistry and Toxicology - Department of Food Science and Toxicology and Environmental Science Program; Adjunct Faculty - Department of Chemical Engineering. (10% teaching, 20% research, 70% service).

1997-2005, Director, Idaho Food Quality Assurance Laboratory, Twin Falls, ID (remote appointment).

1990-95, Adjunct Assistant Professor of Environmental Chemistry and Toxicology - Department of Food Science and Toxicology and Environmental Science Program; Director, Analytical Sciences Laboratory, University of Idaho.

1986-90, Chief Toxicology Chemist – Veterinary Diagnostic Toxicology, School of Veterinary Medicine, University of California, Davis, California.

1986-87, Postdoctoral Research Fellow, with Dr. William M. Jackson, and Visiting Lecturer, Department of Chemistry, University of California, Davis, California.

Association of Public and Land-grant Universities-USDA-NIFA National Award for Teaching Excellence. 2014.

University of Idaho-College of Agriculture and Life Sciences, Excellence in Teaching Award. 2013.

Harrison Prescott Eddy Research Medal, Water Environment Federation (WEF). 2009.

Northwest Academic Computing Consortium (NWACC), Outstanding Project Prize. 2008.

University of Idaho Excellence in Teaching Award, 2007.

Fellow of the *International Union of Pure and Applied Chemistry* (IUPAC). 2005.

Fulbright Scholar Fellowship - Greece. Communicating Risks to Lesvos Island, GR Water Resources and Public Health Resulting From Environmental Degradation. Department of Environmental Studies, University of the Aegean. *Council for the Intl. Exchange of Scholars* (CIES). 2005.

US National Library of Medicine/Society of Toxicology TOX-LEARN International Toxicology Education Project, steering team co-chair. 2003-2005.

Biographical Sketch

University of Idaho Excellence in Outreach Award, 2003.

Outstanding Faculty Award, UI Environmental Sciences Program, 2001.

NASULGC Academic Programs Committee on Organization and Policy (ACOP)/Experiment Station Committee on Organization and Policy (ESCOP) National Leadership Development Program Fellowship (Washington, DC and Purdue University), 1993-1994.

B. Related Peer-Reviewed Publications

Doblin, M., Fan, T., Foster, S., Garrett, W., Maher, W., Möller, G., Oram, L., Roach, A., and Wallschläger, D. 2010. Environmental Sources, Speciation and Partitioning of Selenium in: Chapman P.M., Adams W.J., Brooks M.L., Delos C.G., Luoma S.N., Maher W.A., Ohlendorf H.M., Presser T.S., Shaw D.P. (eds). Ecological Assessment of Selenium in the Aquatic Environment. SETAC Press, Pensacola, FL, USA.

Oram, L. L., Strawn, D. G., and Möller, G. 2010. Rhizosphere Selenium Speciation and Bioavailability in Symphyotrichum eatonii from Reclaimed Mine Soils. Environmental Science and Technology DOI: 10.1021/es1029766.

Oram, L. L., Strawn, D. G., Morra, M. J., and Möller, G. 2010. Selenium Biogeochemical Cycling and Fluxes in the Hyporheic Zone of a Mining-Impacted Stream. Environmental Science and Technology 44 (11), 4176–4183. DOI: 10.1021/es100149u.

Newcombe, R.L., Rule, R. A., Hart, B.K. and Möller, G. 2008. Phosphorus Removal from Municipal Wastewater by Hydrous Ferric Oxide Reactive Filtration and Coupled Chemically Enhanced Secondary Treatment, Part I. Performance. *Water Environment Research* 80(3):238-247 doi:10.2175/106143007X221003.

Newcombe, R.L., Strawn, D. G. Grant, T., Childers, S. E., and Möller, G. 2008. Phosphorus Removal from Municipal Wastewater by Hydrous Ferric Oxide Reactive Filtration and Coupled Chemically Enhanced Secondary Treatment, Part II. Mechanism. *Water Environment Research* 80(3): 248-256. doi:10.2175/106143007X220987.

Newcombe, R.L., Hart, B.K. and Möller, G. 2006. Arsenic Removal from Water by Moving Bed Active Filtration. *Journal of Environmental Engineering* 132(1): 5-12.

C. Patents

Möller, G. and Strawn, D.G. Biochar Water Treatment, PCT Application No. PCT/US2014/066677. Patent Pending. 2014

Möller, G., Brackney, K., Hart, B., Newcombe, R., Korus, R. Reactive Filtration. US Patent RE44,570; November 5, 2013

Möller, G. and Newcombe, R. Water Treatment Method. US Patent 8,080,163; December 2011

Möller, G. Reactive Filtration. US Patent 7,744,764; June 29, 2010

Möller, G., Brackney, K., Hart, B., Newcombe, R., Korus, R. Reactive Filtration. US Patent 7,713,423; May 11, 2010

Möller, G. Reactive Filtration. US Patent 7,445,721; November 4, 2008.

Möller, G., Brackney, K., Hart, B., Newcombe, R., Korus, R. Reactive Filtration. US Patent 7,399,416; July 15, 2008

D. Synergistic Activities (Teaching)

Principles of Sustainability (3cr) Upper Division/Graduate Level
http://www.webpages.uidaho.edu/sustainability/

Principles of Environmental Toxicology (3cr) Upper Division/Graduate Level
http://www.webpages.uidaho.edu/etox/

Food Toxicology (3cr) Upper Division/Graduate Level
http://www.webpages.uidaho.edu/foodtox/

Outreach: Cofounder of *Leadership Idaho Agriculture Foundation* and keynote speaker (“The Hard Work of Leadership”) in this early career training program for 12 years.

E. Active Research Grants

N-E-W Tech™: Innovation at the Nutrient, Energy, Water Nexus. Idaho Global Entrepreneurial Mission (IGEM), Idaho Department of Commerce (2015) $427,000

Biographical Sketch for Robert Tripepi

Department of Plant, Soil and Entomological Sciences
University of Idaho
Moscow ID 83844-2339
e-mail: btripepi@uidaho.edu
Phone: (208) 885-6635
Fax: (208) 885-7760

Education

Ohio State University, B.S., Horticulture, 1977
Pennsylvania State University, M.S. Horticulture, 1980
Purdue University, Ph.D. Plant Physiology, 1984

Academic Employment

Professor of Physiology and Horticulture, Plant Sciences Division, Department of Plant, Soil and Entomological Sciences (PSES), University of Idaho, Moscow (1998 – present)
Associate Professor of Physiology and Horticulture, Plant Sciences Division, PSES, University of Idaho, Moscow (1991 – 1998)
Assistant Professor of Physiology and Horticulture, Plant Sciences Division, PSES (1984 – 1991)
Research Assistant, Department of Horticulture, Purdue University (1980-1984)
Research Assistant, Department of Horticulture, Pennsylvania State University (1977-1979)

Teaching Experience (Current courses)

Principles of Horticulture (lecture and laboratory) – 3 credit course
Nursery Management and Laboratory – 4 credits in two courses
Plant Tissue Culture Techniques (lecture and laboratory) – 3 credit course
Plant Propagation (lecture and laboratory) – 3 credit course
Landscape Maintenance (lecture and laboratory) – 3 credit course
Senior Seminar – 1 credit course
Internship (in Plant Science) – variable credit course from 1 to 6 credits
Directed Study (in Plant Science) – variable credit course from 1 to 6 credits

Relevant Professional Experience

Advisor for the student club (Plant and Soil Science Club) (1995 – present), University of Idaho

Outstanding Academic Advisor in the College of Agricultural and Life Sciences in 1996, 2006, and 2012.

Outstanding Student Organization Advisor at the University of Idaho in 2006.

Teaching Fellow Award from the North American Colleges and Teachers of Agriculture. 2014.

Internship Coordinator for the Plant Sciences Division in the Department of Plant, Soil and Entomological Sciences at the University of Idaho, (2011 – present).

Active participant in undergraduate research efforts (directed study courses); past mentor of multiple students involved in the TRIO program (summer internship program for minority high school students, including American Indian and Hispanic students).

Research Publications (since 2009)

Knerr, A.J. and R.R. Tripepi. 2014. Changes in bacterial communities in dairy manure during 9 months of composting as determined by Denaturing Gradient Gel Electrophoresis. Acta Horticultureae 1034:399-407.

Knerr, A.J. and R.R. Tripepi. 2014. Changes in fungal communities in dairy manure during 9 months of composting as determined by Denaturing Gradient Gel Electrophoresis. Acta Horticultureae 1034:409-415.

Love, S.R., R.R. Tripepi, and T. Salaiz. 2014. Influence of harvest timing and storage interval on rabbitbrush seed germination, emergence, and viability. Native Plants Journal 15:98-108.

Love, S.R., R.R. Tripepi, and T. Salaiz. 2014. Influence of stratification, light and plant depth on rabbitbrush seed germination and emergence. Native Plants Journal 15:109-118.

Ridout, M.E. and R.R. Tripepi. 2011. Initial chemical and physical properties of potting mixes amended with anaerobically digested cattle biosolids. Acta Horticulturae 891:167-172.

Perez, J., S. Eigenbrode, L. Hilje, R. Tripepi, M.E. Aguilar, and F. Mesen. 2010. Use of grafting to prevent *Hypsipyla grandella* (Zeller) (Lepidoptera:Pyralidae) damage to New World Meliaceae species. Pest Management 39:618-625.

Rideout, M.E., and R.R. Tripepi. 2009. Improving seed germination of native perennial *Phlox longifolia*. Native Plants J. 10:80-90.

Perez, J., S. Eigenbrode, L. Hilje, R. Tripepi, M.E. Aguilar, F. Mesen. 2009. Leaves from grafted Meliaceae species affect survival and performance of *Hypsipyla grandella* (Zeller) (Lepidoptera: Pyralidae) larvae. Journal of Pest Science. (On-line journal) ISSN 1612-4766

Book Chapter:

Tripepi, R.R. 2015. Micropropagation of Woody Plants. Pp. 365 – 376. *In*: C.A. Beyl and R.N. Trigiano, Eds., Plant Propagation: Concepts and Laboratory Exercises. Second edition. CRC Press, Boca Raton, FL.

Biographical Sketch
Terry Tindall, J. R. Simplot Company

Terry A. Tindall is the Senior Agronomist for the J.R. Simplot Company and located in Boise Idaho. He received his B.S. from Brigham Young University and M.S. and Ph.D. from Oklahoma State University.

Summary

Terry A. Tindall is the Senior Agronomist for the J.R. Simplot Company and has world agronomic responsibilities for supporting the company's agribusiness goals. Terry Tindall received his B.S. from Brigham Young University and M.S. and Ph.D. from Oklahoma State University. He is very active in several organizations including International Plant Nutrition Institute, The Fertilizer Institute, Fluid Fertilizer Foundation and Conservation Tillage Information Center and International Fertilizer Association. His program focuses on new fertilizer technologies and improving nutrient use efficiency including a better understanding of fertilizers and their relationship to the 4-R's of nutrient stewardship. He is a recent recipient of the American Society of Agronomy Industry Agronomist of the year award.

Publication Article

Dr. Tindall's program has focused mainly in soil fertility and agronomic understanding of new fertilizer technologies and improving nutrient use efficiency. He currently directs or has been involved in research activities in many diverse areas of the world from Argentina to Zimbabwe to S.E. Asia. He is a well sought after speaker in both national and international programs providing educational understanding of nutrient inputs while balancing those inputs with environmental stewardship.

Tindall has authored or co-authored 100's of publications and presented papers providing information in both North American and International conferences. He believes the fundamental role of an industry agronomist is to help produce safe nutritious food in feeding a hungry world. This should be done by balancing environmental stewardship in the communities we live in and as well as providing economic viability for growers we influence.

Dr. Tindall's most recent articles and points of interest have focused on improving food security with commercial fertilizers. It has been estimated that population increases to 9 billion people within the next generation will continue to put a tremendous strain on available arable land just to produce crops and vegetables to provide for the basic needs of this burgeoning population. However, predictions are that a more affluent population will require not only a larger quantity of food, but also a more diverse food source. The answer to these requirements is a balanced input of more land, improved genetics, wise-use of irrigation as well as precise applications of fertilizer. The small but incremental improvements in yield and production efficiencies will be the main-stay in meeting these needed sustainable yields. As a society we also need to move forward in more diligent

manner to advance our understanding of these agronomic principles it other areas of our planet where some of the dramatic needs are the most apparent. The goals of sustainability in balance with environmental stewardship are lofty goals for all professional agronomists, but certainly worthy of a larger community effort.