Byproducts Component

Problem Area 1. **Develop Beneficial Uses of Agricultural, Industrial, and Municipal Byproducts**

Problem Statement

Rationale. Agricultural, municipal, and industrial processes result in a wide array of byproducts. Many of these byproducts, if properly processed and used, may have specific benefits to water quality, soil quality, plant health, plant and animal production systems, and to reduce undesirable air emissions. In order to achieve these benefits, the byproducts need to be utilized in an environmentally sound manner that reduces the cost of disposal or converts them into marketable assets. While previous ARS research has resulted in acceptance of byproducts (i.e. foundry sand), there are many materials and applications for which little scientific information exists or potential benefits have yet to be identified.

Research needs. Technologically sound methods are needed for utilizing byproducts that will be characterized as beneficial. This includes blending, composting, and amending byproducts as well as developing land application and management techniques that will improve soil, water, and air quality in addition to improved plant growth. Specific sub-areas of research include development of application technologies, measurement of fate and transport of byproduct components, measurement of treatment efficacy and controlling processes, identification of beneficial properties, and cost-benefit evaluations. The overall objective is to utilize agricultural, municipal, and industrial byproducts in a cost-effective and environmentally sound manner.

Byproducts Problem Area 1. **Develop Beneficial Uses of Agricultural, Industrial, and Municipal Byproducts**

Inputs/Resources	Outputs/Products	Outcomes
Location Contribution: Auburn, AL Beltsville, MD Bowling Green, KY Clay Center, NE Florence, SC Madison, WI Miss. State, MS Oxford, MS Watkinsville, GA West Lafayette, IN Cooperators National Council for Air and Stream Improvement Inc. (NCASI), Livestock Integrators NPRI, Coal Ash Association, Commodity Assn., agribusiness, university scientists, state soil and water conservation commissions, conservation tillage alliances, state and local regulators.	New and improved systems to capture, concentrate, and reuse nutrients from manures and other byproducts. Guidelines for using byproducts to stabilize or sequester nutrients in manures and soils. Procedures to use manure, compost, and byproducts to remediate and improve soils and to formulate manufactured soils. Knowledge of the effects of manure and byproducts to promote plant health and product quality. Product Users: byproduct generators, and producers (farmers and land managers); regulators (U.S. and state EPAs), action agencies (Army Corps of Engineers, NRCS, SWCD),	**Long-term:** Procedures will be used to evaluate, process, and apply byproducts for benefit. **Short-term:** Byproducts will be used for improvement of soil and the environment, remediation of degraded or contaminated soils. Byproducts will be used as components of manufactured soils.

Problem Area 2. **Develop Risk Assessments Trace Elements and Xenobiotics in Byproducts for Beneficial Uses in Agriculture and Horticulture**

Problem Statement

Rationale. Each year in the U.S., millions of tons of agricultural, industrial and municipal byproducts are generated. Alternative uses for these byproducts are needed to promote sustainable agriculture as well as to reduce landfill space requirements, greenhouse gas emissions, and disposal/remediation costs. Many of these byproducts have characteristics that make them prospectively useful as soil amendments whether for direct land application, soil reclamation and remediation, or as components of manufactured soils and composts. US-EPA is actively encouraging Industrial Materials Recycling, with regulations adopted at the State level. At this time, state regulatory agencies lack evaluation tools for environmental acceptability of beneficial use of these byproducts in agriculture or horticulture. The ARS will conduct research to provide critical information about constituent phyto- and bio-availability in byproduct amendments to state regulatory agencies, and how to use these data to conduct pathway risk assessments to support use decisions.

Research needs. Many regulators are reluctant to approve land application, soil manufacturing and other agricultural and horticultural uses of byproducts because of a lack of knowledge of interactions with soil, nutrient bioavailability, groundwater impacts, and impacts on other soil-related functions and processes. The development of methods to examine and approve byproducts based on sound science will simultaneously ensure environmental protection, improve soil, water and air quality, and derive economic benefits to both byproduct generators and the agricultural community. Accurate and cost-effective methods of byproduct evaluation must be established. The specific research goals are to (1) identify agricultural, municipal, and industrial byproducts amenable to beneficial use in agriculture and horticulture; (2) develop a generic framework by which risks of byproducts of different origin and constituents can be evaluated; (3) identify analytical methods that can accurately identify and quantify byproduct risks from constituents using proper QA/QC; (4) develop a Decision Tree to help stakeholders determine which evaluation methodologies are appropriate for matching byproducts with intended uses--then develop a “branching” evaluation protocol that proposes analyses that could ultimately be carried out in independent laboratories and universities; and (5) characterize a number of different byproducts (including variability) using the generic framework to demonstrate to stakeholders that the proposed framework yields comparable and reproducible data.

Byproducts Problem Area 2. **Develop Risk Assessments for Beneficial Uses in Agriculture and Horticulture**

Inputs/Resources	Outputs/Products	Outcomes
Location Contribution: Auburn,AL Beltsville, MD Bowling Green, KY Clay Center, NE Florence, SC Cooperators Foundry Industry Recycling Starts Today (FIRST), EPRI, USEPA, US-FDA, State Regulatory agencies, universities, farming community, ASTM, National Council on Air and Stream Improvement, GLBMA, American Coal Ash Assn.	Generic test models or analyses. Decision trees for state, city, or local agencies. Guidelines on beneficial uses. Product Users State regulators and local permitting agencies.	Short-term Sampling, analysis, and assessment protocols for byproducts. Long-term A model process by which different types of byproducts can be evaluated for use in agriculture and horticulture. Development of generic evaluation methods for potential land applications.

Air Quality Component

Introduction

Bioaerosols, list compounds, emission factors move to processed based models
Recognize that system studies need to be conducted…
Information that certain management practices or technologies will be used as the basis for making sound decisions about environmental benefits, such as carbon credits.
Making sound decisions on reducing the impact of livestock production on the environment, improving sustainability by reducing the carbon footprint, and improving air quality.

Problem Areas

1. **Measure concentrations and quantify emissions**

Objectives

a. Develop appropriate methods and protocols to measure concentrations and emissions from animal agriculture (Dungan & Leytem)
Todd, Cole—Bushland—NH3, GHG—Beef cattle, Dairy
Dungan, Leytem—Kimberly—endotoxins, bioaerosols, NH3, GHG, VOC—dairy
Trabue—Ames—VOC, Reduced S, PM—swine, poultry
Spies—Clay Center—GHG, NH3, H2S—beef cattle
Moore—Fayetteville—NH3—poultry
Ro—Florence—NH3, GHG—poultry, swine
Miles—Mississippi State—NH3, GHG—poultry
Silva, Loughrin—Bowling Green—PM, VOC—poultry, swine

b. Determine emission factors from various production practices (Dungan & Leytem)
Animal units, field application, etc
Todd, Cole—Bushland—NH3, GHG—Beef cattle, Dairy
Dungan, Leytem—Kimberly—endotoxins, NH3, GHG, VOC—dairy
Trabue—Ames—VOC, Reduced S, PM—swine, poultry
Spies, Varel—Clay Center—GHG, NH3, H2S—beef cattle
Moore—Fayetteville—NH3—poultry
Ro—Florence—NH3, GHG—poultry, swine
Miles—Mississippi State—NH3, GHG—poultry

Anticipated Products

- Scientifically sound methods for the research community to accurately measure airborne compounds
- Quantify spatial and temporal variations in emissions for commodity groups and other government agencies
- Special ARS session on emission factors for future EPA emissions conferences.

- Publications and fact sheets on the state of science of emission factors for delivery to stakeholders (extension, producers, action agencies, commodity groups, and industry personnel)

2**. Develop and test abatement technologies and improved management practices**

a. <u>Evaluate impact of diet modification on emissions</u> (Kerr)
Miller—Lincoln—H2S, VOC—beef
Todd, Cole—Bushland—NH3, GHG—Beef cattle
Moore—Fayetteville—NH3—poultry
Spies, Woodbury—Clay Center—GHG, NH3, H2S—beef cattle
Kerr, Trabue—Ames—NH3, VOC, Reduced S—swine

b. <u>Evaluate impact of animal/facilities management on</u> emissions (Miles)
Kerr, Trabue—Ames—NH3, VOC, Reduced S—swine
Miles, Brooks—Mississippi State—NH3, GHG, bioaerosols—poultry
Moore—Fayetteville—PM, endotoxin, NH3—poultry, swine
Woodbury—Clay Center—NH3, GHG—beef
Vanotti, Szogi, Ro—Florence—NH3—swine, poultry

c. <u>Evaluate impact of manure handling, storage, & treatment on emissions</u> (Szogi)
Vanotti, Szogi—Florence—NH3—swine, poultry
Todd, Cole—Bushland—NH3, GHG—Beef cattle
Miller—Lincoln—GHG—Beef cattle
Moore—Fayetteville—NH3—poultry, swine
Whitehead, Cotta—Peoria—microbes, H2S, GHG—swine
Miles—Mississippi State—NH3, GHG—poultry
Dungan, Leytem—Kimberly—bioaerosols, NH3, GHG, VOC—dairy
Varel—Clay Center—VOC, NH3, microbes, GHG—beef, swine
Loughrin, Lovanh—Bowling Green—VOC, GHG, NH3—swine, poultry

d. <u>Evaluate impact of land application on emissions</u> (Watts)
Watts—Auburn--GHG, NH3—poultry
Miles—Mississippi State—NH3, GHG—poultry
Sistani, Lovanh—Bowling Green—GHG, NH3—swine
Pote, Moore—Fayetteville & Booneville—NH3—poultry
Moorman—Ames—microbes—swine
Dungan, Leytem—Kimberly—bioaerosols—dairy

Anticipated Products

- Delivery of cost effective BMPs that reduce emissions to producers, extension, and action agencies
- Delivery of improved systems for the handling and storage of manure that increase manure value to producers, extension, and action agencies

- Delivery of peer-reviewed reports documenting the effectiveness of abatement technologies and practices that reduce emissions and enhance manure value to producers, extension, and action agencies

3. **Model emissions based upon physical, chemical, and biological processes**

   a. Identify and verify existing process-based models (Todd)

   Todd, Cole—Bushland—NH_3—beef
   Ro—Florence—NH_3, GHG—swine, poultry

   b. Identify critical physical, chemical, and biological processes contributing to emissions (Loughrin)

   Todd, Cole—Bushland—NH_3, GHG—Beef cattle, Dairy
   Dungan, Leytem—Kimberly—endotoxins, NH_3, GHG, VOC—dairy
   Trabue—Ames—VOC, Reduced S, PM—swine, poultry
   Spiehs, Varel, Woodbury, Eigenberg—Clay Center—GHG, NH_3, H_2S—beef cattle
   Moore—Fayetteville—NH_3—poultry, swine
   Ro, Szogi, Vinotti—Florence—NH_3, GHG—poultry, swine
   Miles—Mississippi State—NH_3, GHG—poultry
   Loughrin, Lovanh—Bowling Green—VOC, GHG, NH_3—swine, poultry
   Whitehead, Cotta—Peoria—microbes, H_2S, GHG—swine
   Miller—Lincoln—VOC, microbes, NH_3, GHG—Beef cattle

Anticipated Products

- Knowledge of fundamental processes and mechanisms controlling emissions from animal agriculture for use by other scientists and model developers
- Databases of input variables and emissions for evaluating process-based models for use by other scientists and model developers
- Scientific peer-reviewed manuscripts describing new knowledge of mechanisms affecting emissions available to the scientific community, action agencies, and extension

Breakout Session - Andy Cole/Karamat Sistani/Roger Eigenberg

Breakout #6

Component: Management, Enhancement, and Utilization of Manure Resources

Problem Area 1. Animal Nutrition, and Management

Problem Area 2. Collection, Storage, Treatment, and Utilization of manure

Problem Area 3. Utilization of manure in an integrated farming system to improve soil, water, and air quality.

Problem Area 4. Manure as a renewable energy resource.

Breakout #6 edits & additions

Component: Management, Enhancement, and Utilization of Manure Resources

Problem Area 1. Animal Nutrition and Management Effects on Manure Quantity and Quality.

Problem Statement: Modifying the diet of livestock and poultry affects nutrient retention in the animal as well as the quantity and nutrient content of manure. Through diet modification it may be possible to improve production efficiency while decreasing nutrient losses to the environment.

Objectives/Outputs:

1. **Evaluate the nutrient availability of co-products from the bio-fuels industry**

2. Feed processing and diet formulation recommendations that balance animal production and environmental outcomes.

Locations: Ames, Iowa; Bushland,TX. Clay Center, NE; Mississippi State, Miss.

Problem Area 2. Collection, Storage, Treatment, and Utilization of Manure

Problem Statement: Significant losses of nutrients often occur during collection, storage, and application of manure. Best management practices and new technologies are needed to efficiently utilize manure and protect soil, water and air quality. Treatment can be enhanced with the combined use of biological, chemical and physical methodologies, especially as part of holistic systems.

Objectives/Outputs:

1. **Alternative technology to control runoff and improve water reuse in feedlots.**
2. **Develop improved treatment technologies for managing nutrients, conserving water, and reducing odor, pathogens, PM_{fine} and GHG emissions (Cross-cutting).**
3. **Develop separation technology to concentrate and recover phosphorus and nitrogen from manure.**
4. **Develop improved methods for lagoon clean out and restoration.**
5. **Assessment of environmental credits from implementation of alternative manure treatment technologies.**
6. **Develop tools to locate manure build up in beef feedlots to mitigate pathogens and EDCs (Cross-cutting).**
7. **Improved constructed wetlands to prevent off-farm release of manure nutrients.**

Locations: Florence, SC, Clay Center, NE, Bushland, TX; Bowling Green, KY.
Products:

1. **Reduction of runoff and improved water reuse for feedlots**
2. **Improved treatment technology to manage nutrients, reduce odors, pathogens, PMfine, and GHG from manure.**
3. **Concentrated phosphorus and nitrogen fertilizers.**
4. **Improved methods for lagoon cleanup.**
5. **Approaches for assessment of environmental credits (carbon and nutrients).**
6. **Precision management techniques for control of pathogens and EDCs.**

Product Users
Livestock producers, NRCS, EPA, state and federal regulators, general public, consulting engineering industry, other researchers, and Livestock and Poultry Environmental Learning Center. Information will be provided to users through scientific publications, patents and licenses. ASABE standards, NRCS practices and ARS websites.

Problem Area 3. Utilization of manure in integrated farming systems to improve soil, water, and air quality.

Problem Statement: Increasing complexity in production systems are requiring integrated farming systems to efficiently utilize manure resources and protect soil, water, and air resources.

Objectives:

1.) Application practices to utilize manure and protect the environment: i.e. application rates, timing, techniques

Products:
Decision aids for determining application rates, and timing for various manure products.
Locations:
Auburn, AL
Bowling Green, KY
Madison, WI
Miss. State, MS
Orona, ME

2.) Field management to utilize manure and protect the environment: i.e. tillage practices, cropping systems, cover crops.

Products: Crop and tillage practices to minimize leaching and runoff losses of nutrients applied as manure.

Locations:
Auburn, AL
Bowling Green, KY
Miss. State, MS
Watkinsville, GA

3.) Practices to minimize off-site impacts: i.e. buffer strips, grass hedges, riparian filter strips.

Products: BMP's to minimize off-site impacts.

Locations:
Lincoln, NE
Ames, IA
Bowling Green, KY
Clay Center, NE
Bushland, TX
Coshocton, OH
Miss. State, MS
Temple, TX

Tifton, GA
University Park, PA
West Lafayette, IN
Florence, SC

Problem Area 4.   Manure as a renewable energy resource.

Problem Statement: Develop integrated biological and thermo-chemical technologies and systems to produce renewable energy from manure.

Objectives/Outcomes:

4AA Biological methods

- **Microbial sources of Hydrogen from manure**
- **Generate electricity using microbial fuel cells powered by manure**
- **Anaerobic co-/ digestion to produce combined heat and power from manure**
- **Development of alternative anaerobic digestion to produce heat and power from manure**
- **Development of nutrients for algal systems to sequester carbon and produce renewable energy from manures**

4AB Thermo-chemical / biological methods

- **Development of on site farm-scale pyrolysis/gasification systems to produce heat, power, and biofuels from manure for treatment and use.**
- **Characterization of manures feedstock for their suitability for existing and emerging energy conversion systems.**
- **Develop precision manure harvesting approaches to provide high quality product for thermo-chemical conversion processes**

4AC Co-products use and carbon credit protocols

- **Evaluation of bioenergy coproducts as soil amendments for enhanced production and carbon credits.**

Products from Problem Area 4:

- **Working microbial fuel cells for electricity from manures**

- **Working bioreactors for hydrogen production from manures**
- **Working more economical alternative and/or co-/anaerobic digestion systems for combined heat and power**
- **Specific cooperative agreement with thermo-chemical conversion technology companies for implementing farm-scale energy production system**
- **Establishment of protocols to quantify carbon credit from utilizing manures as feedstock for biological and thermo-chemical conversion systems**

Locations for Problem Area 4: Beltsville, MD; Clay Center, NE; Florence, SC; Bushland, TX; Bowling Green, KY

Component: Manure Pathogens and PACs

1) Kimberly Cook – Co-Chair (KY – MSA)
    a) Fate Transport Pathogens
    b) Odors
    c) Swine/Chicken
2) Cliff Rice – Co-Chair (Beltsville)
    a) PACs
3) Michael Jenkins (GA – S)
    a) Fate Transport Pathogens
    b) Chickens/Dairy
4) Mark Ibekwe (CA – W)
    a) Fate Transport Pathogens
    b) MST
    c) Dairy
5) John Brooks (MS – MSA)
    a) Fate Transport Pathogens
    b) Chickens/Swine
6) Tom Moorman (IA)
    a) Fate Transport Pathogens
    b) Swine

Research Problem Area & Subsets

1) **Microbial Pathogens**
    a) Fate and Transport (Manure, Air, Soil, & Water)
        i) Microbial Ecology
    b) Microbial Source Tracking
        i) TMDLs
2) **Pharmaceutically Active Compounds (Veterinary Pharmaceuticals & Natural Hormones)**
    a) Fate and Transport (Manure, Air, Soil, & Water)
    b) Environmental Frequency
    c) Source
3) **Antibiotic Resistant Bacteria (Pathogens & Commensals)**
    a) Fate and Transport (Manure, Air, Soil, & Water)
    b) Environmental Frequency
    c) Source
4) **Best Management Practices(s) and treatment technologies for Mitigation and Risk Management**

Statement Outline

1) Microbial Pathogens

Statement:

1) Relationship between manure pathogens to public health issues

Objective: Determine the fate and transport of pathogens from different animal production systems under different regions to surface water, ground water, soil, and crops.

Deliverables: Peer-reviewed information necessary to develop predictive systems and prevent transport.

a. Source identification to determine extent of problem
    i. Fate and Transport (Manure, Surface Water, Ground Water, Soil, Tile Drainage & Air)
        1. Inactivation Rates
        2. Persistence
        3. Transport Modeling
        4. Source Tracking
    ii. TMDL

2) **Pharmaceutically Active Compounds (Veterinary Pharmaceuticals & Natural Hormones)**

Statement:

1) Relationship between manure PACs to public and environmental health issues

Objective: Determine the fate and transport of veterinary pharmaceuticals from different animal production systems under different regions to surface water, ground water, soil, and crops.

Deliverables: Peer-reviewed information necessary to develop predictive systems and prevent transport of veterinary pharmaceutical compounds.

Objective: Determine the fate and transport of endocrine-active natural products from different animal production systems under different regions to surface water, ground water, soil, and crops.

Deliverables: Peer-reviewed information necessary to develop predictive systems and prevent transport of endocrine-active natural products.

a. Source identification to determine extent of problem
    i. Fate and Transport (Manure, Surface Water, Ground Water, Soil, Tile Drainage & Air)
        1. Identify PACs and determine persistence
        2. Biodegradation
        3. Sorption
        4. Source Tracking

3) Antibiotic Resistant Bacteria (Pathogens & Commensal)

Statement:

1) Relationship between agricultural antibiotic resistant bacteria to public health issues

Objective: To determine the frequency of antibiotic resistant organisms/genes in various agricultural regions and their transfer to surface water, ground water, soil, and crops.

Deliverables: Data necessary to assess agricultural impact on antibiotic resistance in the environment and public health.

   a. Source identification to determine extent of problem
      i. Fate and Transport (Manure, Surface Water, Ground Water, Soil, Tile Drainage & Air)
         1. Baseline data
         2. Gene transfer/movement

4) **Best Management Practices(s) and treatment technologies for Mitigation and Risk Management**

Statement:

1) Evaluation of BMPs and treatment technologies on impact of fate and transport of pathogens, PACs, and antibiotic resistant bacteria using an integrated research approach.

Objective: To evaluate and validate BMPs and treatment technologies on pathogens, PACs, and antibiotic resistant bacteria immobilization and inactivation.

Deliverables: Recommendations on implementing BMPs and treatment technologies.

   a. Treatment systems for evaluation and immobilization

SY Locations (Not Final)

Problem Area 1

i) Bowling Green, KY
ii) Mississippi State, MS
iii) Ames, IA
iv) Lincoln, NE
v) Riverside, CA
vi) Kimberly, ID
vii) Beltsville
viii) Watkinsville, GA
ix) Bushland, TX

Problem Area 2

i) Mississippi State, MS
ii) Riverside, CA
iii) Beltsville
iv) Ames, IA

Problem Area 3

i) Watkinsville, GA
ii) Bushland, TX
iii) Bowling Green, KY
iv) Mississippi State, MS
v) Ames, IA
vi) Lincoln, NE
vii) Riverside, CA

Problem Area 4

i) Bowling Green, KY
ii) Mississippi State, MS
iii) Ames, IA
iv) Lincoln, NE
v) Riverside, CA
vi) Florence, SC
vii) Watkinsville, GA
viii) Bushland, TX

Writing Assignments

1) **Pathogens:**
    a. **Mike Jenkins (Watkensville) (Lead)**
        i. **Fate and transport**
    b. **Mark Ibekwe (Riverside)**
        i. **Source tracking**
        ii. **Microbial ecology**
    c. **Bill Rice (Bushland)**
        i. **Microbial ecology**
    d. **Tom Moorman (Ames)**
        i. **Fate and Transport**
2) **PACs:**
    a. **Cliff Rice (Beltsville) (Lead)**
3) **Antibiotic Resistant Bacteria:**
    a. **John Brooks (Mississippi State) (Lead)**
    b. **Bill Rice (Bushland)**
    c. **Terry Whitehead (Peoria)**
4) **BMPs and treatment technologies:**
    a. **Kim Cook (Bowling Green) (Lead)**
    b. **Pat Hunt (Florence)**
    c. **Mike Jenkins (Watkensville)**
    d. **Mark Ibekwe (Riverside)**

Deadlines

Dec. 15th – Information to Kim Cook or Cliff Rices