

COLLEGE OF AGRICULTURE AND LIFE SCIENCES

WASTE MANAGEMENT STRATEGIC PLAN

COLLEGE OF AGRICULTURE AND LIFE SCIENCES WASTE MANAGEMENT PROGRAMS

MISSION

The College of Agriculture and Life Science Waste Management Program serves the people of North Carolina through innovative and relevant research and education that improves quality of life through enhanced economic opportunity, environmental quality, and equal access to knowledge and technology.

VISION

Our vision is to become nationally recognized for excellence and leadership in agricultural, industrial, municipal, and on-site waste management research, education, and outreach programs. Waste management research and education priorities will be continually assessed to insure congruence with the mission of the Waste Management Program.

Waste Management Program GOALS

The *Waste Management Program* faculties have identified 11 goals (NOT listed in any priority order) for research, education, and outreach that are consistent with its mission and vision. The strategic goals were identified from our assessment of four fundamental programmatic areas related to technological advances in waste management to include [1] control of waste sources (e.g. animal nutrition; plant and animal genetics; facility management; and water, nutrient, and energy use reduction), [2] treatment, storage, and handling of wastes (e.g. liquid storage, alternative treatment systems, and biosolids handling); [3] utilization of waste resources (e.g. land application technologies, value added processing, and waste use in diverse soil/crop management systems; and [4] impacts of waste utilization (e.g. water, air, and soil quality; economics; human health; and other social issues/impacts). Specific programmatic objectives are further identified under each of the 11 goals that provide focus for allocation of internal resources, securing extramural grant support, and establishing interdisciplinary collaborations. This strategic plan will provide the basic framework for assessment of current resource allocation and potential redistribution of resources needed to address research and education priorities. Current faculty FTE assigned to specific waste management research and extension programs are identified in Tables 1 and 2. To obtain specific programmatic information, NC State University faculty contacts are identified in Table 3.

GOAL 1. Alternative Waste Treatment Systems

Substantial increases in numbers and concentration of confined animal feeding operations over the last decade have led to serious public concerns over the impact of intensive animal production on environmental quality. Current waste treatment systems have evolved to efficiently and economically remove wastes from the source. These systems may include recycling of selected by-products and/or land disposal.

- Develop waste treatment alternatives to lagoon/land application for animal wastes and by-products that are effective, economically viable, and environmentally safe.
- Develop alternative animal production systems designed to conserve and recycle nutrients.
- Evaluate alternative animal housing systems (building/facility design and operation) to reduce adverse environmental quality impacts of animal production.
- Evaluate alternative septic or on-site waste systems to enhance system function, minimize cost, and protect environmental quality.
- Establish and conduct timely and relevant education and outreach programs directed toward waste sources and potential markets for waste products.

GOAL 2. Animal Nutrition

With regard to animal wastes, reducing the impact of waste nutrients on environmental quality requires an integrated approach. An essential component of reducing nutrients in the waste stream involves reducing intake and/or enhancing utilization within the animal.

- Improve nutrient (N, P, Zn, Cu, etc.) utilization efficiency by animals through traditional animal selection or genome manipulation.
- Accurately define animal nutrient requirements (species, age, etc.) to improve diet formulation.
- Develop feed additives (enzymes, peptides, etc.) and/or alternative ingredients to enhance nutrient absorption and utilization efficiency.
- Improve feed manufacturing processes to better reflect specific nutrient requirements and enhance nutrient availability.
- Manipulate animal diets to reduce odors associated with animal waste.
- Develop genetically engineered crops that improve or enhance nutrient adsorption efficiency.
- Develop education programs that enhance adoption of animal nutrition technologies that maintain animal productivity and that reduce nutrient use and/or enhance nutrient utilization efficiency.

GOAL 3. Nutrient Cycling and Transformations in Soil

Reducing the impact of land applied waste nutrients and other elements requires a quantitative understanding of nutrient cycling in the soil, water, plant, and atmosphere continuum. Although substantial knowledge and understanding of nutrient transformations exists, our ability to accurately quantify nutrient fate and transport is limited.

- Improve understanding of N cycling (immobilization, volatilization, denitrification leaching, and crop recovery) from animal, industrial and municipal wastes applied to diverse soils and cropping systems.
- Quantify the fate of P from land-applied wastes and its environmental and agronomic impact.
- Reduce build-up of heavy metals and other elements that may degrade soil and crop quality and result in limiting use of the field for waste application.
- Quantify the impacts of riparian buffers, wetlands, and related technologies on surface and subsurface water quality.
- Improve applied research programs to enhance understanding of the impact of land applied waste nutrients on air, water, and soil quality.
- Develop advanced field-based education and training courses that include basic soil chemical, physical, and biological relationships, and agronomic and nutrient management practices that impact environmental quality.

GOAL 4. Value-added Processing

Alternative uses for nutrients and other constituents in wastes provide a potential economic and environmental incentive to develop marketable products from wastes. Combined efforts between industry, state agencies, and others are essential to develop value added products and alternative uses of waste nutrients.

- Develop value-added products that reduce environmental impacts of concentrated animal production.
- Develop efficient and economic production and marketing systems for value-added products manufactured or processed from wastes.
- Develop alternative products, uses, and/or markets for forage crops used to recover land applied waste nutrients.
- Provide education and outreach programs to encourage adoption of added value products by diverse constituents.

GOAL 5. Measurement and Control of Odor and Emissions

Reducing odors associated with production practices and/or waste management is essential for general public acceptance of agricultural and/or industrial production to occur in proximity to residential areas. In addition, some of the chemical constituents in volatile waste components are potential environmental pollutants, while some may impact human and animal health.

- Develop effective and economical odor monitoring and control methods.
- Evaluate the potential for manipulating animal diets for controlling odors (see Goal 2 - Animal Nutrition).
- Develop odor reduction practices for confined animal production systems.
- Quantify fate and impact of atmospheric emissions of gases (NH₃, CH₄, H₂S, etc.) generated from confined animal production systems.
- Establish extension programs for confined animal operators, rural residents, and others on technologies effective in reducing odors from confined animal production.

GOAL 6. *Watershed Scale Analysis*

In order to fully understand the combined impacts of natural processes and anthropogenic activities on natural resource conservation and environmental quality, interdisciplinary research and education approaches that integrate site-specific (field, farm, and local scale) information scaled to the watershed and/or regional level are essential.

- Quantify the carrying capacity of NC watersheds to accurately estimate source specific limits for nutrient discharge.
- Enhance current efforts to quantify nutrient balance (inputs vs. outputs) at variable scales (field, farm, watershed, state).
- Accurately identify and quantify waste/nutrient sources on a total watershed basis so that corrective activities are scientifically based and cost effective.
- Evaluate the distribution of nutrients produced in quantities exceeding land availability to include regional economically viable waste transportation and management strategies for land-locked producers.
- Provide educational programs in geospatial technologies (GIS, remote sensing, etc.) to enhance watershed scale environment and natural resources assessment and analysis that are essential to assess nutrient use and loading at variable scales.

GOAL 7. *Lagoon Phase-out or Conversion*

With approximately one thousand abandoned waste lagoons and the likelihood that the state government will legislate adoption of alternative swine waste management systems to the lagoon system currently in use. Strategies should be developed to convert and/or close existing lagoons through cost-effective and environmentally sound methods.

- Develop a science based lagoon risk-benefit analysis protocol to prioritize lagoons for closure, retrofit, or preservation.
- Develop strategies for appropriate management of lagoon sludge nutrients (N, P, Cu, Zn, etc.) for minimal environmental impact.
- Develop low cost environmentally acceptable sludge removal and lagoon closure procedures.
- Evaluate alternative lagoon structure uses after phase-out.
- Provide technical materials and training for producers and others on lagoon phase-out technologies that protect the environment.

GOAL 8. *Pathogens and Human Health*

Although several peer research institutions in North Carolina are currently conducting substantial research in pathology and human health issues associated with wastes, the *Waste Management Program* will engage in research and education projects that compliment those efforts.

- Assess potential health risks to animal and humans related to land application of wastes.
- Investigate potential residues and other components in wastes that may adversely affect animal and human health.
- Evaluate waste treatment systems for effectiveness in reducing animal and human pathogens.
- Develop animal housing systems and/or management practices that reduce transmission of pathogens in wastes.

- Evaluate effective control of pathogens from on-site waste.
- Develop and deliver interdisciplinary education programs on technologies that eliminate potential health risks associated with animal production.

GOAL 9. *Land Application Systems*

While considerable discussion of lagoon system conversion or phase-out continues, current lagoon-based animal waste management system design and function can be improved to minimize costs and environmental impacts. Even with alternative waste management systems, land application of waste nutrients will remain an essential component of confined animal production in North Carolina.

- Expand the impact assessment of land-based system design, installation, and maintenance on environmental quality.
- Enhance irrigation system design relative to wettable acres.
- Enhance lagoon operation to reduce N and P in stored waste.
- Evaluate schemes for modifying lagoon treatment systems (lagoon covers, aerated and anoxic zones for denitrification/nitrification).
- Develop strategies to reduce drift and odors from sprinkler irrigation systems.
- Provide interdisciplinary educational programs on land-based animal waste disposal systems to animal waste operators, agricultural and environmental specialists, and other professionals.

GOAL 10. *Septic Waste Management*

In ground septic systems facilitate wastewater treatment for over half of the population in North Carolina. While protecting water resources requires effective system design, installation, and maintenance, little is known about the environmental impact of nearly 1.7 million septic systems.

- Expand research effort in quantifying the impact of wastewater treatment systems on water quality.
- Evaluate new system designs and related technologies that enhance wastewater treatment to minimize impact on water quality.
- Provide extension education and training on wastewater treatment system design, installation, and maintenance to a diverse clientele.

GOAL 11. *Economic, Social, and Policy Issues*

Inherent in each of the previous 10 goals and priorities is a progressive research and education effort to evaluate the economic, social, and policy implications of relevant technologies developed in the *Waste Management Program* or from other sources.

- Develop and enhance markets that will secure the future of U.S. livestock production with respect to foreign competition and waste regulation.
- Provide science-based input for policy analysis on proposed waste management or related environmental quality regulations.
- Provide community decision-making and dispute resolution support related to waste utilization and management that affect soil, water, and air quality.

Table 3. North Carolina State University faculty contacts for specific programmatic information.

PROGRAM GOALS		FACULTY CONTACT	
1	<i>Alternative Waste Treatment Systems</i>	Dr. Mike Williams Department of Poultry Science 134 Scott Hall Box 7608, NC State Raleigh, NC 27695 (919)515-5386 Mike_williams@ncsu.edu	Dr. Phil Westerman Biol. & Agric. Engineering 265 Weaver Labs Box 7625, NC State Raleigh, NC 27695-7625 (919)515-6742 Phil_Westerman@ncsu.edu
2	<i>Animal Nutrition</i>	Dr. Theo van Kempen, Department of Animal Science 325 Polk Hall Box 7621, NC State Raleigh, NC 27695 (919)515-4016 T_vanKempen@ncsu.edu	Dr. Eric van Heugenten Department of Animal Science 211 Polk Hall Box 7621, NC State Raleigh, NC 27695 (919)513-1116 Eric_vanheugenten@ncsu.edu
3	<i>Nutrient Cycling and Transformations in Soil</i>	Dr. Robert Mikkelsen Department of Soil Science 3208 Williams Hall Box 7619, NC State Raleigh, NC 27695 (919)513-3033 Rob_Mikkelsen@ncsu.edu	Dr. John Havlin Department of Soil Science 2234 Williams Hall Box 7619, NC State Raleigh, NC 27695 (919)515-2655 John_Havlin@ncsu.edu
4	<i>Value-added Processing</i>	Dr. Mike Williams Department of Poultry Science 134 Scott Hall Box 7608, NC State Raleigh, NC 27695 (919)515-5386 Mike_williams@ncsu.edu	Dr. John Classen Biol. & Agric. Engineering 179 Weaver Labs Box 7625, NC State Raleigh, NC 27695-7625 (919)515-6800 John_Classen@ncsu.edu
5	<i>Measurement and Control of Odor and Emissions</i>	Dr. Bob Bottcher Biol. & Agric. Engineering 176 Weaver Labs Box 7625, NC State Raleigh, NC 27695-7625 (919)515-6753 Robert_Bottcher@ncsu.edu	Dr. Theo van Kempen, Department of Animal Science 325 Polk Hall Box 7621, NC State Raleigh, NC 27695 (919)515-4016 T_vanKempen@ncsu.edu
6	<i>Watershed Scale Analysis</i>	Dr. Greg Jennings Biol. & Agric. Engineering 213 Weaver Labs Box 7625, NC State Raleigh, NC 27695-7625 (919)515-6771 Greg_jennings@ncsu.edu	Dr. Wendell Gilliam Department of Soil Science 3234 Williams Hall Box 7619, NC State Raleigh, NC 27695 (919)515-2040 Wendell_Gilliam@ncsu.edu

7	<i>Lagoon Phase-out or Conversion</i>	Dr. Frank Humenik Biol. & Agric. Engineering Research IV, Suite 3100 Box 7927, NC State Raleigh, NC 27695 (919)515-6767 Frank_humenik@ncsu.edu	
8	<i>Pathogens and Human Health</i>	Dr. John Classen Biol. & Agric. Engineering 179 Weaver Labs Box 7625, NCSU Raleigh, NC 27695-7625 Voice: (919)515-6800 john_classen@ncsu.edu	Dr. Bob Bottcher Biol. & Agric. Engineering 176 Weaver Labs Box 7625, NC State Raleigh, NC 27695-7625 (919)515-6753 Robert_Bottcher@ncsu.edu
9	<i>Land Application Systems</i>	Mr. Karl Shaffer Department of Soil Science 3403G Williams Hall Box 7619, NC State Raleigh, NC 27695 (919)515-7538 Karl_shaffer@ncsu.edu	Dr. John Classen Biol. & Agric. Engineering 179 Weaver Labs Box 7625, NCSU Raleigh, NC 27695-7625 Voice: (919)515-6800 john_classen@ncsu.edu
10	<i>Septic Waste Management</i>	Dr. Mike Hoover Department of Soil Science 3403 Williams Hall Box 7619, NC State Raleigh, NC 27695 (919)515-7305 Mike_hoover@ncsu.edu	Dr. David Lindbo Department of Soil Science V. James Res. & Ext. Center 207 Res. Station Rd. Plymouth, NC 27962 (919)793-4428 David_lindbo@ncsu.edu
11	<i>Economic, Social, and Policy Issues</i>	Dr. Kelly Zering Agric. & Resource Economics Box 8109, NC State Raleigh, NC 27695 (919)515-6089 Kelly_zering@ncsu.edu	