PD-ABP-010
93766

Project Title: **REGIONAL COOPERATION IN RECYCLING OF BIODEGRADABLE WASTE**

Submitted to: THE MIDDLE EAST REGIONAL COOPERATION (MERC) PROGRAM

BY: U.S. DEPARTMENT OF AGRICULTURE (FAS/ICD/RSED)

IN COOPERATION WITH:
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EXECUTIVE SUMMARY

This project will bring together agencies and representatives in Gaza/West Bank, Jordan and Israel to work together to develop and apply solid waste management techniques and initiate composting programs.

Like communities in all regions of the world, the nations of the Middle East must address growing concerns of health and environmental threats which result from inadequate or limited waste management. In densely populated areas, population growth challenges the ability of municipal authorities to manage waste. In the many areas of the Middle East - especially in rural areas - landfills and other municipal solid waste disposal technologies currently are not available or are inadequate, creating unhealthy and unpleasing environments for residents, and negatively affects tourism. Experts and policy makers must attempt to improve MSW disposal procedures in preparation for the next century

The goal of this project will be to improve of the capabilities of all three regional parties to devise and/or improve solid waste management strategies, and to establish a basis for regional cooperation in management of solid waste. An intrinsic aspect of this management strategy is the development of a composting program for regional communities to focus on the recycling of biodegradable solid waste. This project has agricultural, economic and environmental benefits. Composting and source separation will be central activities of this project.

The participating organizations of this project will examine, analyze, and - where possible - implement environmentally safe and economically sustainable solid waste management technologies, with a focus on composting of municipal solid waste and sewage sludge. The participating experts of this project will devise strategies relevant to Middle Eastern municipalities, emphasizing value added approaches (such as composting, sorting and recycling), private sector development, and non-governmental organization (NGO) strengthening. This project will establish organizational linkages with current and future programs designed to develop and improve infrastructure in the region. The project will support and assist the development of technical efforts at the municipal and rural level, leading to suitable models for management of MSW and sewage sludge under arid conditions in various economic settings that will have immediate relevance for policy makers.

This project specifically will: 1) provide a coherent base and analysis of data on solid waste composition, quantity, location and disposal method, and marketing economic assessment that will provide the necessary information for establishment or improvement of good solid waste management policy for the region; 2) erect pilot-scale composting projects; and 3) establish the economic viability of composting in a environmentally sustainable way.

The pilot projects will introduce composting technology for easily separated biodegradable wastes such as yard and/or farm wastes and sewage sludges and erect a pilot-scale project each in the West Bank and Jordan. The first pilot scale project represents the construction of low technology, low cost composting systems for yardwastes and other biodegradable materials readily separated from the solid waste stream. The second stage to this project will involve construction of a composting plant associated with composting municipal solid waste, and may potentially lead to the development of a municipal recycling facility (MRF). A pilot project will also be developed in Jordan to address composting of sewage sludges.

The capacity and knowledge-base developed through this effort will address specific problems in specific sites and lay the foundation for similar solutions for small and large communities. This work will develop solutions for environmentally and economically sustainable solid waste management, such as composting, recycling, incineration and land filling. At the end of this project, each regional party will have improved human resource and physical capacity to address local solid waste management problems. There will be two working pilot projects in composting solid waste in the West Bank/Gaza and Jordan. There will be improved applied composting technology for the region and the world and a solid waste reference base for the three regional parties. In addition, there will be good technical and policy linkages between regional parties and the U.S. and a basis for future cooperation in solid waste management.

RECYCLING OF BIODEGRADABLE SOLID WASTE
PROJECT PROPOSAL

A. THE NATURE OF THE REGIONAL COLLABORATION TO BE SUPPORTED.

A.1 Regional Cooperation

This project will bring together agencies and representatives in Gaza/West Bank, Jordan and Israel to work together to develop and apply solid waste management techniques and initiate composting programs. These programs will provide an economically and environmentally beneficial means of dealing with municipal solid waste on a local and regional basis. A useful product will be produced, compost, that benefits agriculture and has economic value. This project will provide an additional incentive in the form of likely legislation and regulation in municipal solid waste management. This project provides an appropriate mechanism for cooperation between the governments of Gaza/West Bank, Jordan and Israel and effectively builds bridges of shared goals between them. This project also helps develop infrastructure within Gaza/West Bank and provides opportunities for technical training for personnel involved in the project.

B. THE DEVELOPMENT PROBLEM AND THE PROPOSED RESPONSE.

B.1 The Regional Problem

Local and central governments worldwide are developing new regulations and management strategies and for handling waste, including municipal solid waste (MSW), sewage sludge, waste water, and industrial and agricultural wastes. Urbanization, burgeoning populations, and the reality of limited natural resources pose enormous challenges to existing infrastructures requiring better, more efficient management approaches for disposal and/or recycling of waste. Like communities in all regions of the world, the nations of the Middle East must address growing concerns of health and environmental threats which result from inadequate or limited waste management. In densely populated areas, population growth challenges the ability of municipal authorities to manage waste. In the many areas of the Middle East - especially in rural areas - landfills and other municipal solid waste disposal technologies currently are not available or are inadequate, creating unhealthy and unpleasing environments for residents, and negatively affects tourism. Researchers and policy makers must attempt to improve MSW disposal procedures in preparation for the next century.

The area to be considered under this project includes Israel, West Bank, Gaza Strip, and Jordan. The area can be geographically divided into the Mediterranean and Red Sea coastal areas, central mountain area, the Jordan Valley, high desert and steppes. The region is typified as arid and semi-arid, scarce in water resources and arable soil.

Overgrazing, deforestation, soil erosion and desertification are major environmental problems. Efficient solid waste management strategies are essential to protect the existing resource base, especially water. Sufficient quantities of composts can be used to remediate contaminated, saline or highly eroded soils.

The utilization, reuse and recycling of solid waste is of prime importance in the region vis-a-vis the lack of adequate soil organic material. The soils in the region, especially marginal soils, must be developed and maintained to support he increasing population. High quality compost can increase soil organic material, conserve soil moisture, thereby optimizing the use of water in agriculture, and thereby give a significant economic and environmental return to the agriculture sector.

Despite differences in the emphases and level of development of management schemes for handling solid waste, Middle Eastern populations share common goals in addressing a mutual problem: a) development of management strategies that will address both future needs and current problems and protect limited resources, especially ground water; b) development, or improvement, of technologies that increase the resource potential of recycled waste; and c) improve access to new technologies as they are developed and improve the ability to determine their usefulness locally. Problems addressed and resulting actions taken must be both local and regional in scope. These strategies should be applicable in other Middle Eastern municipalities and areas. The strategies, models and technologies developed in the project can catalyze cooperation by offering solutions that will reduce current regional environmental, health and aesthetic problems. Efforts must also be affordable and sustainable in their appropriate milieu. If these conditions are met, then these efforts will enhance and promote regional cooperation and development.

B.2 The Sectoral and Institutional Context of the Problem

B.2.1 The West Bank/Gaza. It is arguable that, of the three regional parties, the Palestinian population of the West Bank and Gaza have the most urgent need for solutions. The population is about 2.1 million (.7 and 1.4 million respectively)[1]. There are only two dump sites, one in Hebron (which has a relatively high level of metals by comparison to the other) and one in Nablus (where landslide danger and high leakage diffusion risk existed to the valley below).

Several studies have detailed the current extent of the problem of MSW management in the Middle East, including the World Bank publication, Developing the Occupied Territories, Volume V, Infrastructure, and the - as yet unpublished - report by the Government of Italy under the Middle East Peace Process. Both reports note the need for improved solid waste disposal services. Modern, sanitary landfill sites for disposal of MSW do not exist, and most MSW is simply dumped outside municipal boundaries,

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1 The source of all population statistics is the CIA World Factbook, 1993.

occasionally burned to reduce volume. Both practices generate serious environmental and health threats to the entire population. Immediate action must be taken to improve the conditions of MSW management in the West Bank and Gaza Strip. This may best be addressed by improving their capability and capacity to establish legally and clearly accountable solid waste services and to develop broad management strategies for solid waste disposal. This could be achieved through technical assistance and training activities, upgrading existing disposal practices, and supporting their capacity to identify least-cost alternatives to disposal. In the final analysis, improving capacity to make rational choices in private, public and non-profit sectors, will make a larger and lasting impact.

To the greatest extent possible, the emphasis on West Bank/Gaza will be to focus on applied, lower cost technologies through survey, evaluation, training, and finally establishing a demonstration site/pilot project. The project will emphasize coordination with other assistance programs designed to develop the infrastructure of the West Bank/Gaza, such as the World Bank and AID's bilateral program.

B.2.2 Jordan. The population of Jordan is about 3.8 million and its territory encompasses 100,000 km^2. Eighty percent is desert, and the vast majority live in the greater Amman area (about 520 km^2.) The municipal governments have responsibility for solid waste management. Management programs of solid waste in Jordan have increased in the last decade, especially with the passage environmental laws during the early 1980s. Major dumps operate in El Marka, Al Hombra, Khirbet El Samra and Ruseifa. Risk of contamination of the water table exists during rainy periods. Collection of solid waste in small, rural villages is not considered as well managed as that in the larger municipalities.

The population of Jordan increased dramatically before, during and after the Gulf War. Repatriation or migration centered on large urban areas, especially Amman and waste treatment programs that had been planned for pre-war estimates were severely strained. A good example of the resulting problem is evident in the Khirbet el Samra Waste Water Treatment Plant, which has received an approximately 39.5% greater volume of waste water for treatment than projected during its planning phase. Although waste treatment is not the focus of this program, a related problem of sewage sludge must be examined and preparations made for its management. Jordan's policy for accumulation of sewage sludges would be to fill in the accumulation area, and construct over the landfill. In this case, Khirbet el Samra resides in the midst of good agricultural land, and the land would likely be placed back into agricultural production. Research indicates that high concentrations of sewage sludge in soils can result in increased heavy metal uptake by crops. In addition, pathogens and parasites are present in sludges and can be transmitted by crops grown on the landfills. This poses a significant health risk to consumers, especially young children. Composting of sewage sludges can have beneficial effects with leaving little or no chemical residues, heavy metal concentration or biological pathogens.

The focus of this project for Jordan will be on developing technologies for composting and/or bioremediation of sewage sludge, and analyzing policies that support solid waste management. The project will analyze of lower cost technologies and, if necessary, assist in the development of public outreach programs.

B.2.3 Israel. The population of Israel is about 4.5 million and its territory encompasses 20,000 km. There is a large dump in Tel Aviv, also its largest urban center, a separation and composting site in Hadera, and a paper recycling plant in Afula. According to studies, Israeli waste is composed of about 67% biodegradable material, 17% paper and cardboard, 7% synthetic materials, 5% metals and glass, and 4% miscellaneous materials. The total quantifiable waste is projected to be about 2.2 million tons/year by the year 2000.

The Israeli National Outline Scheme is an examination of technological alternatives for managing the waste. The plan calls for streamlining landfills, closing several hundred local garbage dumps, setting new standards for hazardous waste, and introducing new recycling requirements. The recommendation, however, does not consider the likelihood of increased economic cost in managing large and growing sanitary landfills. Nor has the plan solved the garbage problem of Israel's metropolitan core, as voiced by nearby rural settlements that have become sites for waste disposal. Importantly, the strategy does not address one of the main problems associated with the waste stream in Israel - as in most Middle Eastern countries - that the constituency is largely biodegradable and wet by comparison to waste streams in U.S. and Europe. This is because a larger percentage of food makes up the waste. Sorting technology is especially important when considering the implementation of composting and/or recycling paper.

Israel has established collaborative research with the U.S. in composting technology that can be readily used or enhanced for use with this program. This will leverage available resources for this program. The focus for Israel in this project will be to enhance or improve technologies needed for cost-effective production of high-quality composts.

B.2.4 Common needs. The nature of solid waste management in all three areas requires improved strategies and technologies. Minimally the problem is unsightly and odorous, and at worst a threat to human and animal health, can intrude on scarce ground water sources, and pollute or take out of use scarce arable lands. Badly managed dumps in this area are breeding grounds for pathogens, parasites, and disease carrying insects and animals. All three regional parties have devised strategies in recent years to try to deal with the problem of solid waste management, or have recognized the need to develop rational, cost effective approaches. As already noted, the problem in the region is such that it is treated under the Middle East Peace Process Working Group on Environment by the Government of Italy. Both Israel and Jordan have developed strategies in the 1980s to try to deal with the problem, and the Palestinian Authority have developed an official bureau to deal with the issue of

managing solid waste in the West Bank and Gaza.

B.3 The Project Objective: How it will resolve or substantially contribute to the resolution of the stated problem.

B.3.1 Goal. The goal of this project will be to improve of the capabilities of all three regional parties to devise and/or improve solid waste management strategies, and to establish a basis for regional cooperation in management of solid waste. An intrinsic aspect of this management strategy is the development of a composting program for regional communities to focus on the recycling of biodegradable solid waste. This project has agricultural, economic and environmental benefits. The capacity and knowledge-base developed through this effort will address specific problems in specific sites and lay the foundation for similar solutions for small and large communities. This work will develop solutions for environmentally and economically sustainable solid waste management, such as composting, recycling, incineration and land filling. Composting and source separation will be central activities of this project.

B.3.2 Specific Objectives. The participating organizations of this project will examine, analyze, and - where possible - implement environmentally safe and economically sustainable solid waste management technologies, with a focus on composting of municipal solid waste and sewage sludge. The participating experts of this project will devise strategies relevant to Middle Eastern municipalities, emphasizing value added approaches (such as composting, sorting and recycling), private sector development, and non-governmental organization (NGO) strengthening. This project will establish organizational linkages with current and future programs designed to develop and improve infrastructure in the region. The project will support and assist the development of technical efforts at the municipal and rural level, leading to suitable models for management of MSW and sewage sludge under arid conditions in various economic settings that will have immediate relevance for policy makers.

B.4 Relationship between the Objective and the National and Regional Development Goals and Priorities

The following descriptions of each component are illustrative examples of ways in which this project will address country-specific objectives. It will be necessary for the regional parties to work through an advisory committee (see Section F.1) and in conjunction with international donors to fully integrate this project with on-going projects and infrastructure development. At that time, the project objectives can be refined and prioritized.

B.4.1 West Bank/Gaza.

Objectives: a. Support the development of institutional capacity to develop strategies for optimal disposal of biodegradable and non-biodegradable MSW. b. Introduce technical assistance and training activities to upgrade existing disposal practices, and initiate studies to identify least-cost alternatives to disposal, which may include composting as well as environmentally safe alternatives, such as landfills and/or incineration.

Action: a. Collect, compile and analyze data. b. Establish at least one demonstration site to introduce and test various technologies necessary to establish optimal models. c. Provide training in the region and in the U.S. for technicians, economists and entrepreneurs. d. Work with local private sector firms, NGOs and the emerging Palestinian public sector to develop policies that would lead to the application of economically efficient technologies, strategies and decision models. e. Support the improvement of WB/G research and field testing capabilities.

Objective: c. Develop broad management strategies for solid waste disposal with input from participating municipalities, environmental experts, the service sector, and clients.

Action: a. Promote and enhance linkages between regional and international organizations with those working in Gaza and the West Bank to establish MSW strategies; establish or enhance public outreach programs. b. Engage local populations to communicate their needs and desires to the service sector and to participate in recycling and other participatory programs that would alleviate the burden of separation by the MSW industry.

B.4.2 Jordan.

Objective: Develop strategies and technologies for management of sewage sludges, emphasizing composting.

Actions: a. Collect, compile and analyze data. b. Establish at least one demonstration site to introduce and test various technologies necessary to establish optimal models. c. Provide training in the region and in the U.S. for technicians, economists and entrepreneurs; and d. work with local private sector firms, NGOs and the public sector to strengthen policies that lead to the application of economically efficient and environmentally friendly technologies. e. Establish a cooperative research program with Israel, WB/G and the U.S. to develop the best methods and applications for composted sewage sludge.

B.4.3 Israel.

Objective: Enhance technologies that can be tested and implemented during the life of this project. Improve current Israeli policies with appropriate recommendations.

Action: Conduct studies on: a. organic waste management and applications; b. environmental legislation; c. evaluation of composting, sorting and utilization technologies in the Middle East Region; and, employing these studies, develop viable strategies through economic evaluation.

B.5 Other Major National and Regional Activities

B.5.1 Peace Process Initiative. The Government of Italy is sponsoring an activity in solid waste management under the Middle East Peace Process. The activity will first address developing a reference base of information on solid waste in the region. Second, a pilot-scale solid waste management site will be selected and implemented. The USDA project will not duplicate efforts conducted under the Italian activity since both groups have agreed to work together and coordinate activities in the region.

B.5.2 Initiatives undertaken by the Regional Parties. The Israeli Ministry of Environment policy specifically calls for the establishment of two to five privately owned, publicly subsidized central land fills located far from urban population centers. NGO's in the region have objected to this policy for fear that this system will be perpetuated and will not motivate the development of recycling.

C. THE RATIONALE FOR ADDRESSING THE PROBLEM IN A REGIONAL CONTEXT.

C.1 Advantages of the Project as a Regional Cooperative Undertaking and the Benefits to the Participating National Institutions.

There are several advantages to addressing the problem of managing solid waste in a regional context in addition to the desire to bring formerly warring populations together in the spirit of cooperation. First, the focus of this project will be on the regional parties who border one another and share many of the same geographic challenges in devising strategies that can address local needs. For example, ground water resources which are at risk likely have more than one regional party with a vested interest. It is likely that these regional populations are at risk due to municipal solid waste dump sites. Animals and insects carry disease from the dump sites to communities and between borders.

One of the most important reasons for regional collaboration -besides the peace dividend - is the possibility of developing a mechanism, such as a regional council or a regional agreement, that would establish policies to conserve and protect vulnerable, limited resources that exist in the region. The establishment and sustainability of such a mechanism would be up to the regional parties and at higher levels of government than would be involved in this project. However, this and other similar projects can establish the base of knowledge and technical linkages that can support and give input to such a mechanism.

This integrated program for treatment of solid wastes may include consideration of such options as separation, recycling, composting, land filling and incineration, or a combination of any or all of the options. All technologies will have to be environmentally sensitive and economically efficient. West Bank/Gaza, Jordan and Israel will participate in this program at the level considered to be of primary importance to their individual needs or requirements thus assuring benefit to each individual regional party and individual participating institutions.

C.2 Why and how the parties to the project would make greater progress working together than they would make working separately on the problem.

If a strategy or technology works well for one geographic area, it increases the likelihood for its success in proximal geographic locations. In some sense this is the cultural--technological diffusion familiar to anthropologists. Frequently, a single solution may address many problems, thus maximizing a solution's impact and eliminating or minimizing redundant efforts. In addition, having more than one organization or group address a problem increases organizational resources, increases the potential for new ideas and solutions, and expands the pool of human resources. Collaborative projects in research, policy and development have been based on this premise for many years.

C.3 Institutions and Lead Experts, Implementation, and Coordination.

Jordan Technical Coordination and Steering Committee Members:

Dr. Muwaffaq Saqqar, Jordan Ministry of Water and Irrigation
Representative, University of Jordan Water Research Center

Jordan Advisory Committee:
Ministry of Environment Representative
Municipal Solid Waste Industry Representative

Palestinian Technical Coordination and Steering Committee Members:

Prof. Marwan Haddad, Al Najah University
Dr. Jamal Safi, Gaza Environmental Protection and Research Institute

Palestinian Advisory Committee Representatives:

The Palestinian Authority (Solid Waste)
UNDP - Jerusalem or Save the Children - Gaza and West Bank

Israeli Technical Coordination and Steering Committee Members:

Prof. Yona Chen or Yitzhak Haddar, The Hebrew University of Jerusalem
Prof. Yoram Avnimelech, Technion University

Israeli Advisory Committee Representatives:

Representative, Israeli Ministry of Environment
Representative, Solid Waste Industry (Composting)

U.S. Technical Cooperators:

Dr. Rufus Chaney, U.S. Department of Agriculture
Prof. Harry Hoitink and Prof. Douglas Southgate, Ohio State University
Dr. George Garland, U.S. Environmental Protection Agency

U.S. Advisory Committee Cooperators:

The National Composting Council (various members), including U.S. Private Sector Companies
Dr. George Garland, U.S. Environmental Protection Agency

Italian Advisory Committee Cooperator(s): (two members from Italian Project)

C.4 Planned Visits and Intra-Regional Travel

At least three intra-regional planning and steering committee meetings will take place during the course of this project. The first will be a planning meeting to re-evaluate the project workplan, establish the first year's plan, progress markers for the year, safety parameters, if health or safety risks exist for a particular activity, and determine the next meeting time and site in the region. The second and third meeting will occur as scheduled by its preceding meetings to review the previous year's activities, determine if the objectives had been met, determine what should be modified, and establish a plan for the subsequent year. Additional intra-regional travel between participating regional professionals, officials, and solid waste industries will be determined at each planning and steering committee meeting. In addition, it is anticipated that each regional party will have the option to have two 6-month training sessions per year in the U.S. to be coordinated by Ohio State University. Any additional training or professional visits outside of the region will have to a) meet the objectives delineated for the project, and b) be approved in the annual planning and steering committee (except as noted in Section F.3).

U.S. experts will take part in the annual steering and planning committee meetings annually, and will travel to the region for additional consultations when deemed

necessary during the annual planning and steering committee meetings. It is anticipated that at least one or two additional trips will be conducted by U.S. experts to the region during the course of this project.

D. THE TECHNICAL APPROACH TO BE TAKEN TO THE PROBLEM AND THE RATIONALE FOR THAT APPROACH.

D.1 Project Components

D.1.1 Specific Objectives (restated from B.3)

The participating organizations of this project will examine, analyze, and - where possible - implement environmentally safe and economically sustainable solid waste management technologies, with a focus on composting of municipal solid waste and sewage sludge. The participating experts of this project will devise strategies relevant to Middle Eastern municipalities, emphasizing value added approaches (such as composting, sorting and recycling), private sector development, and non-governmental organization (NGO) strengthening. This project will establish organizational linkages with current and future programs designed to develop and improve infrastructure in the region. The project will support and assist the development of technical efforts at the municipal and rural level, leading to suitable models for management of MSW and sewage sludge under arid conditions in various economic settings that will have immediate relevance for policy makers.

D.1.2 Project Components

This project will contain three components:

- Survey of solid waste and comparison of solid waste management systems, including market assessment for value-added products and economic assessment
- Systems assessment, analysis, development and improvement of solid waste management and technology through establishment of composting demonstration sites, field testing and training
- Policy evaluation, modification and development.

The project will address these three components in the context of the public and private sectors and the non-governmental organization (NGO) community. Each regional party will have the flexibility to determine how each of these components should be emphasized to best meet national and municipal objectives. While each regional party will address selective components individually, the project advisory committee will oversee integration and coordination of these efforts in the region. This advisory committee is further described in Section F.2.

A data survey will first be conducted. The project will address the quantity of available, appropriate organic material and at what cost (including tipping fees, collection, etc.). Next, the type of available organic material will be studied, including the carbon-to-nitrogen ratio, particle size, etc. Care will be taken to ensure that potential contaminants are removed or separated. The market availability will be ascertained in order to determine the level of quality of compost desired. Having ascertained the quantity, quality and market availability, the commitment of land, labor, and capital investment required to compost the available organic material will be identified and an operational plan developed. Finally, the plan will be implemented.

D.1.2.1 Survey of solid waste and comparison of management systems

Project experts will develop a baseline of data to be collected, which will include information on quantities, concentration and composition of municipal solid wastes in selected small communities in the West Bank, Gaza, Israel and Jordan. Because the approach of this project is regional, the parameters of each activity will be assessed by each participating regional party (see Section F.2). Current collection systems will be assessed by household surveys. This component will be conducted in cooperation with the solid waste management activity managed by the Government of Italy under the Middle East Peace Process. The Government of Italy has already initiated an activity to establish a reference base for data on solid waste in the Middle East, including Israel, Jordan and the West Bank and Gaza.

Market assessment and economic analysis of compost use for agricultural and hobby markets will be evaluated according to local demands, safety regulations and existing economic data. The project will identify and conduct economic and market development studies as appropriate. The project will also recommend guidelines for quantity and quality of end product (degree of maturity) for various uses, including approved levels of heavy metal content. Data collection and household surveys will also extended later to include large communities once the existing data for each regional party has been assessed.

D.1.2.2 Assessment, analysis, development and improvement of solid waste management and technology using demonstration sites and training.

Demonstration sites. Demonstration sites to test and introduce composting technologies will be established in this project in sites that will be selected during the evaluation process. Efficient processes for production of composts and suitable compost application rates for agriculture and other uses will then be determined. Applications will be based upon U.S. and European guidelines and modified to meet local needs. Although the appropriate system will be selected during the life of the project, it is envisioned that initially a small-scale windrow (long, narrow piles) composting site will be selected in a small West Bank or Gaza village with intensive agricultural production nearby (animal and crop production to have a viable source of

biodegradable material). This will provide the opportunity for initial training and testing early in the project. Assessment and analysis based on the survey will provide enough information to determine good site locations for the municipal solid waste composting pilot. Systems to be considered will include the passive pile approach, windrow composting using a loader for turning, windrow composting using specialized windrow turners, aerated static pile systems, and in-vessel systems.[2]

In these sites, project experts will review and test current technologies according to environmental standards, compost quality and economic factors at each demonstration site and share this information with the Advisory Committee. Based on this analysis and the economic, social, and political considerations of each regional party, participants will develop recommendations for the best technology (or combination of technologies) to employ. These recommendations will be made available to the regional officials through the Advisory Committee to stimulate interest.

Technology improvement. The project will support the improvement of appropriate composting and MSW technologies. Some of the world's leading technical expertise on composting of MSW and sewage sludge technology already exists in the Middle East. The technical capabilities in these countries will be paired with U.S. cooperators to further the state-of-the-art in MSW management and will be introduced through demonstration sites in all participating areas. Advances in this area will have benefits not only for the Middle East, but for the U.S. as well. Improved technologies will be tested in demonstration sites, or in already established operations where permitted. Three areas on which this component will focus will include: 1) the use of compost as container media; 2) the use of compost for suppression of soil-borne pathogens; and 3) characterization of heavy metal availability in organic waste and its effects on agricultural production in arid conditions.

1) The use of compost as a container media. Composting, which is one viable alternative to the disposition of solid waste, is the breakdown of organic waste materials by mixed populations of microorganisms in a thermophilic aerobic environment. The final product is compost or humus, which is of value in agriculture because it improves the structure and moisture-retention properties of soil and supplies plants with nutrients. Composts produced from agricultural wastes, such as composed grape marc (CGM) and composted separated cattle manure (CSM), have been studied for their suitability in replacing imported peat as the organic component in media for container-grown plants, as well as their chemical and physical properties, in several vegetables and ornamental plants. In plant grown tests, CGM and CSM were used as the organic components of container media and were found to have positive effects, expressed by improved

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[2]On-Farm Composting Handbook, Northeast Regional Agricultural Engineering Service, Cooperative Extension, Ithaca, New York.

physical, chemical and biological properties of the media.

Compost is an economically and ecologically sound alternative to expensive imported peat for greenhouse grown plants. Although extensive research has been devoted to compost produced from tree bark, composted CSM and CGM as well as municipal solid waste (MSW) have the advantage of being produced from raw materials, available in many regions of the world which lack forests, such as the Middle East. The focus of this research would be on the use of CSM, CGM and MSW composts for use as container media and its market viability as such.

2) The use of compost for suppression of soil-borne pathogens. Soil-borne pathogens cause heavy losses to important crops. This is especially true for crops that are grown frequently or continuously in the same plot, causing rapid disease build up. Successful control of these pathogens can be achieved by using pesticides and soil fumigants, yet they are toxic substances by definition and nature. Research has shown that the goal of minimizing pesticide use is attainable using biological control. The use of microorganisms (e.g., *Trichoderma spp.*) to control plant pathogens has been quite promising. Quality and quantity of organic matter in soil affect plant growth and health. Mature composts have been shown to suppress a number of soil-borne pathogens. Suppressive container media offer an opportunity to examine these mechanism and develop new methods - or strategies that can be adopted by farmers - to control soil-borne agents using non-chemical control methods.

3) Characterization of heavy metal availability in organic waste and effects on agricultural plants in arid conditions. One limiting factor in the practical use of municipal solid waste and sewage sludge compost may be the presence of toxic heavy metals. For the determination of the spatial variability of relevant heavy metal content in organic waste and soil, existing data will be aggregated analyzed. The analysis will result in a table of concentration ranges of relevant heavy metals for certain wastes and soils. It is essential to conduct these studies in the region in various soils since soil type as well as the climate have influence on the risk from these compounds. From these results, a model organic waste compost with respect to heavy metal composition and content will be selected for further analysis. The analysis will include total element content (N, P, K, Ca, Mg, Na, Fe, Mn) and relevant waste heavy metal content.

Bioavailability tests will be conducted under greenhouse conditions: two types of soil (sandy and clay) will be amended with three levels of municipal solid waste or sewage sludge compost, and will be incubated in a growth chamber for variable time periods. The soils will then be tested in greenhouses using heavy metal accumulator plants (spinach, cucumbers, and cabbage). After several weeks the plants will be harvested and analyzed for heavy metal content.

Technology transfer and training. Training will provide required and desired technology to each of the participating regional parties in preferred areas. Training will be based on individual institutional needs and will be identified once the assessment of data needs has been determined. However, it is likely that training will include several of the following areas, and will include the use and maintenance of related equipment:

- cost reduction and odor minimization through improved engineering design;
- preparation of value-added products through inoculation of composts with microorganisms providing natural biological control of plant diseases;
- kinetics of decomposition for low-tech efficient out-of-doors and in-vessel composting technology under feed back process control;
- training of pilot plant employees and trainers
- removal of heavy metals and inerts through manual and mechanized sorting approaches - municipal solid waste;
- refinement of process kinetics to remove odors and decrease retention times as well as total costs;
- bioremediation of contaminated soils with byproducts from solid wastes;
- composting manures to reduce fly reproduction and pathogen transmission;
- cost evaluation of solid waste management systems; and
- risk assessment of solid waste management systems.

It is anticipated that much of the training will take place through conducting this project in the field and in Middle Eastern institutions. In addition, given Ohio State University's vast experience in the field of composting and its technical and professional linkages with the U.S. composting industry (see Annex II), it is also anticipated that 1 six-month training periods per participating regional party per year (for a total of 9 over three years) will take place at the Ohio State Agricultural Research and Development Center. Individuals will visit waste treatment and processing facilities, compost utilization industries, and perform developmental activities in conjunction with these visits. The objective of these training visits will be to give the participants "real world" experience in successfully operating plants in the U.S. and Israel.

In addition, training in the region will focus on hands-on training in demonstration sites, environmental risk assessment applied to the potential sites, kinetics of composting, etc. Training will be structured so that redundancy is eliminated and to build human resource capacity for solid waste management systems.

D.1.3 Policy evaluation, modification and development.

This project will provide input through the development and analysis of coherent data recommendations for the development of policies that promote accountable public and private sector MSW services. The survey and analysis of current quantities, composition and disposition of solid waste, and the economic and market analyses that will be conducted will provide the basis of recommendations that promote the use of

environmentally friendly MSW management strategies. Economic analyses of available MSW management alternatives will be conducted to develop incentives. This project will also analyze current policies, both municipal and environmental, as well as the level of private sector involvement in the solid waste industry of the West Bank/Gaza, Egypt and Israel.

While cogent public sector policies and enforcement strategies are necessary to improve MSW management, citizens' groups and NGOs also have a critical role. This project will involve citizens' groups and NGOs, such as the U.S. National Composting Council and others in the development of the policy recommendations and in the dissemination of public information.

In addition, the private sector can directly benefit from or be hampered by national or municipal policy decisions. Well-designed economic incentives can have positive impact on the emergence of private sector MSW services and/or associated industries. Thoughtful policies can positively influence the investment strategies of international multilateral development banks. This project will provide the expertise of U.S. and regional businesses that are actively involved in areas such as provision of MSW services, technology development, or policy reform by having regional experts or policy people interact with U.S. counterparts in appropriate fora, such as the project's annual planning meeting, Biocycle conferences, etc.

By utilizing the expertise of universities and federal and municipal government agencies, the private sector, and the NGO community, it will be possible to develop multilateral linkages with similar organizations from the West Bank/Gaza, Egypt and Israel. These linkages will promote regional cooperation and development of MSW management policies that address the concerns of all interested parties.

An important element of solid waste management is systematic cost-benefit analysis of the various systems. This project will also develop expertise to perform this function specific to the solid waste management industry. In addition, this cost-benefit analysis will be applied to compare current solid waste management systems with alternative strategies.

D.2 The State of Knowledge Relevant to the Objective and Consistency with Current Knowledge

Management of solid waste in the Middle East has depended primarily on landfills; small-scale, localized recycling; or incineration. Landfill technology in the U.S. and other countries has improved substantially in recent years, keeping pace with environmental legislation and municipal zoning restrictions. Recycling technology for non-biodegradable materials, such as aluminum, glass, metals and plastics, and for some biodegradable material, such as paper has greatly improved, as has public awareness of waste management matters. Many large U.S. cities experience difficulties

in collection and transportation of separated MSW for recycling, a problem that has occasionally discouraged residents from recycling.

Value-added approaches, such as composting and recycling, are receiving increased attention in the United States. In some areas waste accumulation is beginning to exceed the capacity of municipal landfills. Environmental legislation and municipal zoning restrictions have increased the need to improve technologies in MSW management. The U.S. Environmental Protection Agency (EPA) and U.S. Agriculture Land Grant University system (and more recently, USDA) have worked in collaboration at the federal level to establish public sector policies and guidelines to promote the use of environmentally sensitive MSW management strategies. These strategies have emphasized composting and land application of biodegradable materials. From the perspective of natural resource conservation, methods such as composting and recycling offer both economic and environmental benefits.

Properly managed organic MSW can be used beneficially in agriculture. Stable composts stimulate plant growth by releasing plant nutrients and provide biological control of soil borne plant pathogens. This reduces the need for pesticides and hazardous soil fumigants such as methyl bromide. Regular and proper use of composts also improve soil quality, reduce erosion, and increase water retention. The use of composts can also reduce or eliminate the use of peat for soil treatment. The economic benefit to local agriculture can be properly analyzed once the cost of producing mature compost is known. Most research on the use of solid wastes in agriculture has been performed in temperate regions of the world; less is known about the fate of MSW-associated pollutants and pathogens in arid high temperature parts of the world such as the Middle East. As such, the research conducted in this project would be of great value to all arid and semi-arid regions of the world.

D.3 Rationale for this Approach

Composting increasingly is chosen as the preferred strategy for treatment and re-utilization of solid wastes. It is a less polluting and lower cost alternative to incineration. Many solid wastes after composting offer value-added features. When these factors are included in cost analysis, composting is a less costly alternative to landfilling for an ever increasing proportion of biodegradable fractions in solid waste.

D.4 Relevant Experience and Lessons Learned

Composting of municipal solid waste has gone through a difficult time in most parts of the world. Source separation has solved most of the problems. However, even for mixed solid waste composting, suitable technology is available today that can produce an environmentally acceptable value-added product, yielding positive impacts.

Low cost, low technology systems are now available for source-separated wastes that yield value-added products without causing negative neighborhood impacts (see Marrugg et al, 1993 and Grebus et al, 1994 in the OSU Industry Section, Annex IV). This approach to composting requires, however, that design engineers and plant operators understand practical aspects of composting. Training in both fields is essential to success.

In 1982 Israel had no major activities in recycling of solid wastes through composting. After 10 years of support through research programs like the Binational Agricultural Research and Development Program (BARD), a base of knowledge has been developed that should allow successful partnerships with the West Bank, Gaza and Jordan. In addition, Israel now has two working composting facilities, operated by municipalities. These facilities have similar problems encountered in U.S. systems. Their successes and failures will provide a valuable base of experience for this project. It should be noted that one of the Israeli Technical Coordinators was substantively involved in the design of the two composting plants.

D.5 Costs and Benefits of Undertaking the Objective

Justification of costs associated with this project are best compared with present alternatives. Most of the activity in this project involves real world data collection and analysis, the actual construction of low technology composting sites adjacent to solid waste recovery facilities, the operation of the systems and utilization of the principal by product: compost. This strategy to waste treatment is rapidly being adopted across the Western World as a best management alternative to solid waste problems. Present alternatives to this approach in the Middle East represent negatives, mostly, as described previously in this proposal.

In addition, the value to the farming/nursery industry has been established in both Israel and the U.S. The application of compost in Israel at 10 to 40 tons per hectare will raise yields by 10 to 20 percent above that obtained using the optimal fertilizer application rate. This amounts to an estimated incremental income of $200 per hectare of wheat and $500 per hectare of cotton. Values would likely be even higher for vegetables and fruits but have not been well evaluated.

The economic impact of producing compost versus alternate strategies is often difficult to determine since in Israel, there is no clear differentiation in the data available between the tipping fee, sorting of industrial recyclable waste, and compost production. The estimate is that producing compost costs about $10 per metric ton, and is sold at $10 per metric ton. However, the compost plants in Israel are operated by municipalities and do not consider profitable return on investment a requirement. The costs of production could be lower using lower cost technologies and labor (e.g., composts can be produced at the cost of $6 per ton and sold for $10 to $12 per ton). The market is not close to saturation since all compost that is currently produced in Israel is sold.

The U.S. technology base in composting is quite advanced in the use and operation of low-cost, high-technology options for composting. Most operating systems in the U.S. operate in the private sector on a for-profit basis. For the purposes of sustainability, this project will emphasize for-profit operations in establishing demonstration sites.

D.6 Major Assumptions and Issues Involved in Achievement of the Objective.

A major issue is that municipalities, authorities, and the private sector in the region are willing to invest (in-kind or in-cost) in solid waste management. An assumption is that - given trends in the U.S. and Israel to increase recycling and composting - similar

increases would manifest themselves in the Middle East if reasonably efficient, low-cost systems were to be introduced. In addition, pilot projects will involve - and will eventually be turned over to - local authorities or to local investors (private sector) for continued operation. It is assumed that the demonstration sites can be located in an area or municipality where the local population will demonstrate a vested interest in having such a plant. Another assumption is that the operation will be sustainable when operational costs are covered or a slight profit margin exists. Whether operated by a municipal government. or private sector, the plants will be managed as business ventures to ensure economic sustainability and establish a source of revenue for expansion and technology improvement after the project terminates.

E. SPECIFIC PROJECT PURPOSE AND INPUTS/OUTPUTS (LOGICAL FRAMEWORK)

E.1 The Specific Purposes of the Project Linked to a Time Frame.

The plan is to: 1) provide a coherent base and analysis of data on solid waste composition, quantity, location and disposal method, and marketing economic assessment that will provide the necessary information for establishment or improvement of good solid waste management policy for the region; 2) erect pilot-scale composting projects; and 3) establish the economic viability of composting in a environmentally sustainable way.

The plan is initially to introduce composting technology for easily separated biodegradable wastes such as yard and/or farm wastes and sewage sludges and erect a pilot-scale project each in the West Bank and Jordan. The first pilot scale project represents the construction of low technology, low cost composting systems for yardwastes and other biodegradable materials readily separated from the solid waste stream. This project could potentially lead to the construction of a pilot composting plant associated with a municipal recycling facility (MRF) and financed by the private sector in a joint Israeli-Palestinian industrial zone. Another type will address composting of sewage sludges in Jordan.

The time frame for this project will be as follows:

TIME SCHEDULE

Activity	Year 1	Year 2	Year 3
E.1.1 Data collection	++++++++	++++++++	
E.1.2 Rapid transfer of composting technology	+++++	++++++++	
E.1.3 Evaluation of present system & capacity	++++++++	++++	
E.1.4 Evaluation of alternatives		++++++++	+++
E.1.5 Econ-Market studies	++++++++	++++++++	++++++++

E.1.6 Planning		++++++++	++++
E.1.7 Organization		++++	++++++++
E.1.8 Training	++++++++	++++++++	+++++++++
E.1.9 Construction & Operation		+	+++++++++

E.2 Intermediate Objectives Indicating Rate of Progress

The rate of progress towards meeting major objectives can be gleaned from the time-frame table above. Data collection, analysis of the current state of conditions within the solid waste industry and evaluation of alternatives will be completed by the end of the first year. Market studies and economic evaluation, rapid transfer of composting technology, planning for construction will largely be accomplished by the end of the second year. Construction and operation will have been completed by the third year.

For some separated wastes, feed back-controlled positive pressure ventilated windrow or contiguous piles systems will be considered (see Annex IV). This simple, but highly effective approach to composting of highly biodegradable separated wastes would be operating in each pilot system in the first year. It is anticipated that visits by appropriate personnel to such locations in Ohio will allow rapid transfer of this simple technology. The time scale will vary depending on the success in waste separation activities and ease of technology transfer.

E.3 Required Inputs and Expected Outputs. (see Logical Frame on pages 19-20)

Y. Avnimelech (Technion, Israel), M. Haddad (Al-Najah University, West Bank), and M. Saqqar (Ministry of Water, Jordan) will oversee technical aspects of compost production in the region initially and coordinate these activities with H. Hoitink (Ohio State University, OSU). OSU will coordinate with Ohio industries utilizing the technologies identified as relevant to this project. Field application technology will be coordinated through Technion as well. Y. Haddar and Y. Chen (Hebrew University of Jerusalem, HUJ) will facilitate the development of compost as a plant growth substrate and will facilitate the introduction of technologies and quality control of the product especially as to the problems of plant pathogens, induction of suppressiveness toward plant pathogens, heavy metals and odor control. M. Haddad and M. Saqqar will coordinate field trials and training and identify sites. In addition, M. Haddad will coordinate data collection in the West Bank/Gaza region. Environmental impact and risk assessments will be developed by the U.S. Environmental Protection Agency and OSU, in cooperation with and conducted by all participating regional institutions. Economic and market evaluation will be addressed by M. Sechter (Haifa University), E. Fienerman (Hebrew University) and D. Southgate (OSU) and coordinated with M. Haddad in the West Bank and Gaza and the University of Jordan..

H. Hoitink will coordinate activities for the U.S. and enhance the potential for U.S. technical linkages within the region. It is expected that information transfer will be low input technology driven, as has occurred in this field in the U.S. since 1987. The April 1995 Biocycle Issue demonstrates how recycling and composting have increased in the

U.S. since that time.

Outputs and benefits will include operational composting pilot-scale projects. In addition, technologies that utilize biodegradable waste will have been further developed, tested, evaluated and demonstrated. In addition, this project would support the establishment of a regional materials recovery industry. Indirect benefits would be to establish a solid waste management system that would reduce the need for large tracks of land devoted to landfills, and reduce the volume of environmentally-degrading materials now present, both in dumps and from incineration. Policies based on good science to eliminate or reduce the threat to human health and the environment would also be a direct benefit.

--Logical Framework (see next pages)

RECYCLING OF BIODEGRADABLE SOLID WASTES
PROJECT LOGICAL FRAMEWORK (Section E)

GOAL: improve of the capabilities of regional parties to devise and improve solid waste management strategies, and to establish a basis for regional cooperation in management of recycling biodegradable solid waste	**OBJECTIVELY VERIFIABLE INDICATORS:** Regional experts who can compile and organize information, analyze and make recommendations for strategies, design new operational facilities for composting, and establish linkages with other regional experts and policy people.	**MEANS OF VERIFICATION:** The ability of the regional parties to compile and analyze data, design and operate composting systems, develop and sustain regional technical linkages, and linkages with policy offices.	**ASSUMPTIONS:** Regional parties will continue to pursue multilateral linkages through the Peace Process or some other mechanism. Unexpected political shifts will not hinder the execution of this project.
PURPOSE: The participating organizations of this project will examine, analyze, and - where possible - implement environmentally safe and economically sustainable solid waste management technologies, with a focus on composting of municipal solid waste and sewage sludge. The participating experts of this project will devise strategies relevant to Middle Eastern municipalities, emphasizing value added approaches (such as composting, sorting and recycling), private sector development, and non-governmental organization (NGO) strengthening. This project will establish organizational linkages with current and future programs designed to develop and improve infrastructure in the region. The project will support and assist the development of technical efforts at the municipal and rural level, leading to suitable models for management of MSW and sewage sludge under arid conditions in various economic settings that will have immediate relevance for policy makers.	**END OF PROJECT STATUS:** An improved base of knowledge on the nature of and solutions to solid waste management, including relevant economic and market assessment, in the region will be well established. The ability of the regional parties to interact in the area of recycling biodegradable solid waste will be established. Recommendations for solid waste management strategies will have been presented to the relevant authorities. Operational parameters for small municipal solid waste composting will have been tested and implemented. Private sector linkages and interests will have been sought and established. An operational composting facility will have been established.	**VERIFICATION MARKERS:** Establishment of a reference database in which all regional parties will have an established baseline of data. Facility and informality of information exchange between regional parties. Receipt of strategy recommendations for MSW management by the relevant authorities and their response and reaction to those recommendations. Steady progress as indicated by annual assessments, reports and workplans. Interest by the private sector in investing and continuing in solid waste recycling. Composting facility will be fully operational and business reports indicate sustainable production.	**REQUIRED CONDITIONS/ UNCONTROLLABLE FACTORS:** Municipalities, authorities, and the private sector in the region are willing to invest (in-kind or in-cost) in solid waste management. Trends in the U.S. and Israel to increase recycling and composting - will manifest themselves in the Middle East if reasonably efficient, low-cost systems are introduced. In addition, pilot projects will involve - and will eventually be turned over to - local authorities or to local investors (private sector) for continued operation. It is assumed that the demonstration sites can be located in an area or municipality where the local population will demonstrate a vested interest in having such a plant. Another assumption is that the operation can be considered sustainable when costs are covered or a slight profit margin exists. Whether operated by a municipal government. or private sector, the plants will be operated in as businesses.

OUTPUTS:	SPECIFIC INDICATORS FOR OUTPUTS:	INDICATOR DATA SOURCE(S):	EXTERNAL FACTORS TO REALIZE:
E.1.1 Reference base on quantity, composition, location and disposition of solid waste in the Region. E.1.2. Operational low-tech, low-cost composting system with trained personnel to operate the system. E.1.3 Well developed, detailed report on the state of the Palestinian solid waste collection and disposal systems. E.1.4 Well developed report - to be shared with relevant regional policy offices- that details options for MSW management strategies, parameters for use, & recommendations. E.1.5 Well developed, detailed report that will be part of E.1.4, & will examine cost-benefit of composting and best markets. E.1.6 Detailed plan(s) of action to construct low-cost, tech.. sustainable Municipal Recycling Facility (MRF). E.1.7 Detailed business plan to operate MSW facility. E.1.8 Trained engineers and technicians that operate MRF. E.1.9. Operational MRF.	E.1.1 Acceptance by appropriate authorities and solid waste industry. E.1.2 Site will be producing good quality compost at a steady rate. E.1.3 Acceptance by appropriate authorities, solid waste industry and local population (e.g. parts of report could be published in a local newspaper). E.1.4 Acceptance and indication that recommendations will be implemented by policy officials. E.1.5 (part of E.1.4) E.1.6 Positive feedback from private sector composting industry in the U.S. and Israel. Investment from private sector in the Region. E.1.7 As above. E.1.8 Trained engineers and technicians are capable of operating and maintaining low-cost, low tech facility years 1-2, and MRF in year 3. E.1.9 MRF begins and continues operations during the life of the project.	E.1.1 Solid waste industry, municipalities, local and regional governments, NGOs, other aid organizations. E.1.2 Level of production on site. Off-site testing for quality control of compost (e.g., at HUJ). E.1.3 NGOs, municipal officials, local professional and other organized groups. E.1.4 Local and regional officials, solid waste industry, NGOs, other relevant organized groups. E.1.5 (same as E.1.4) E.1.6 Private sector in the U.S. and in the region. E.1.7 Private sector. E.1.8 Feedback from trainers; evaluation on site by experienced technicians and professionals; ability of plant to sustain steady progress in production. E.1.9 Data generated on site: cost, production, sales, revenues and income.	E.1.1 Cooperation of all relevant industry and municipal officials. E.1.2 Municipal cooperation for source separation. E.1.3 Cooperation of households in responding to survey. E.1.4 Availability or obtainability of relevant data. E.1.5 Same as E.1.4. E.1.6 Interest of the private sector. E.1.7 Availability of relevant data. E.1.8 Trained personnel will work on MRF; trainable personnel pool exists. E.1.9 Private sector interest exists.
INPUTS (including other coordinating projects): 1. MERC: $3 million 2. Other U.S.: $1 million (estimated) 3. U.S. In kind: $131,000 (estimated) 4. Local in kind: $200,000 (estimated) 5. Other: $2 million (estimate)	**QUANTITY OR VALUES OF INPUTS:** 1. $1 million per year 2. $250,000 in years one and two. 3. $41,000 per year 4. Estimated at $100,000 per year. 5. Estimated at $500,000 in year 3.	**SOURCE DOCUMENTS:** 1. AID-USDA PASA 2. Interagency Agreement 3. Estimates to be given in quarterly financial reports. 4. To be negotiated by regional parties with local investors.	**PRECEDENT CONDITIONS** Establishing funding and other in-kind inputs.

F. INSTITUTIONAL ARRANGEMENTS/PROJECT MANAGEMENT.

F.1 Progress Indicators, Assessment and Monitoring.

An annual plan will be developed each year during planning meetings, using the objectives stated in this proposal as guidelines. The first one will be held at the beginning of the project (which would likely be in late Summer or Fall of 1995). The plan would include specific objectives for each activity as related to those delineated in this proposal, a detailed workplan, progress markers for each activity in the workplan, and time frame when the activities would be expected to be carried out. After the first six months of each year, each participating regional group would review the plan informally, establish which project markers had been met, then write a report relating to each activity (data/survey of solid waste, training, demonstration site development and implementation, etc. as described in Section M.1.

At the end of each year of the project, the group would meet again to formally - and as a joint regional activity - review the activities of the previous year, identify progress indicators that were met, explore why unaccomplished progress indicators were not met, identify and discuss any problems that occurred during the previous year and explore potential solutions, and modify and plan the next year's activities. Outside experts not directly associated with the project may be invited to participate should that become a desirable objective.

F.2 Technical and Programmatic Management of the Project

During each annual planning meeting, those who have been involved in each project activity the Technical Group, comprised of those who are working directly on the project, will meet and discuss the activity, its progress and its problems. Possible solutions to problems, potential modifications in workplans, development of an annual plan, and the exchange of ideas will take place between project participants in formal and informal sessions. Each activity will have representatives from each of the regional parties. This particular activity will be fully collaborative. Any singular activity that one group may pursue will be presenting for consideration and critical evaluation by the technical participants. The free exchange of ideas and opinions will be encouraged.

By the end of the technical sessions, each technical group will present a written report relating and evaluating each activity (as noted above), and establishing the next annual plan. Recommendations for modifying workplans will be included if relevant. This report will be submitted to the Steering Committee and to the Advisory Committee for review and consideration.

The Advisory Committee will be composed of one official from the Ministry that regulates solid waste management criteria (i.e., Ministry of Environment) and one solid waste industry representative (preferably from the private sector) from each regional party, and one or two members from the Italian Solid Waste Initiative. The Advisory

Committee will function as: 1) a communication channel between this project and relevant policy and industry sectors of each regional party; and 2) a voice for the policy and industry sectors to the project. The Advisory Committee Members will be observers and participants during technical presentations, reviews and discussion of each annual planning meeting. They will then meet, discuss and report - in writing - their views of the submitted annual plan to the Steering Committee. In addition, each member will be responsible to report or use information developed in this project for the improvement of the solid waste management systems under their sphere of influence.

The Steering Committee will have overall responsibility for final decisions in all activities. Since all members will be taking part to some extent in the implementation of activities, each member will have a vested interested in the success of activities. In addition, the Steering Committee will have to address concerns or issues that are raised by the technical groups and the Advisory Committee. The Steering Committee will have to approve each annual plan. In the unlikely case that the Steering Committee rejects a recommendation for modification either from the technical groups or the Advisory Committee, a justification will have to be given as part of the meeting minutes.

The Steering Committee will have two members each from each regional party's institutions that are working directly on the project, plus two member from the U.S.

Should small changes in plans be required during the life of the project that will affect only an individual institution or individual party, the party in question will notify the Project Administrator (Eileen Herrera) in writing with a specific request and justification. The Project Administrator will, if deemed necessary, consult with appropriate parties, and if the requested change is judged to support the objectives of the project, will approve the request in writing.

F.3 Identification of Managerial Problems in Implementation.

Each regional party will have a project leader for each activity in which they will be participating. Each project leader will be responsible for implementation and management of his or her component of each activity and to share information on the activity's progress with other regional project leaders, U.S. Cooperating Scientists, and the Project Administrator.

Problems - either managerial or otherwise - will be identified in the six month and annual reports and during discussions at the annual meetings as already noted. Problems that arise that seriously hinder progress, that cannot be addressed in the annual meeting in a timely fashion, will be brought to the attention of the USDA Project Administrator. The Project Administrator will address these problems with appropriate parties and make recommendations to the appropriate Project Leader, or otherwise undertake whatever action may be necessary to resolve the problem. Problems that may occur as a result of local policies may be addressed to the Advisory Council members for that party for

recommendations or possible assistance.

As noted in the MERC Guidelines, national (U.S. and those of the appropriate regional party) regulations and international protocols are to be followed in all communications and exchanges of materials. This will be specified in grant agreements with performing institutions, explained to all regional parties so that the requirements are clear, and emphasized once again when such exchanges are likely to take place.

The primary grantee - in this case, USDA/FAS/ICD/RSED - will carry out subgrant agreements with all performing institutions where appropriate. All **subgrantees will know and comply with grant requirements** as these will be specified in each subgrant agreement. In addition, many of the performing institutions have already conducted activities under grant agreements with USDA or A.I.D. and, therefore, have experience in U.S. Federal requirements, including procurement, travel, use and application of EPA guidelines where appropriate, accountability and financial responsibility.

F.4 Internal Peer Review Mechanisms.

Research will be a relatively small component of this activity, however, all research workplans, as well as data collection, surveys and other activities requiring standardized - or harmonized - protocols will be peer reviewed by appropriate institutions, such as the USDA/CSREES university peer review system for research, the National Science Foundation or other appropriately identified researchers not involved with the project.

Data and survey protocols will be coordinated with the Italian Solid Waste Initiative, since one of their activities to be implemented in the near future - by the time this project would begin - is the establishment of a reference base of solid waste in the region. The project will use as much of this database as is possible in order to eliminate redundancy and wasted resources. Additional data collection and survey will be conducted as needed by the project to meet objectives. In addition, one or more Italian expert(s) from the Italian National Agency for New Technology, Energy and the Environment (ENEA) will invited to participate in the annual planning meetings.

G. Role of the U.S. Experts, institutions or Consultants.

G.1 Role in Activities Essential to the Successful Accomplishment of the Project.

This project will be organized about tasks and subprojects involving facility site selection, monitoring, production and distribution. Each of these areas will be supervised by local personnel. U.S. input will be limited to technical and administrative consultation and training not available in the region, helping to

periodically reviewing programs, as noted in following descriptions.

USDA/FAS/ICD/RSED RSED will the primary grantee for this activity. As such, RSED will responsible for establishing subgrants, passing through funding to performing institutions, and for submitting financial reports to A.I.D. (to be prepared by performing institutions) and other required or requested documentation to A.I.D. In addition, RSED will be the primary point of contact with A.I.D. on this project, with STATE and the Government of Italy in support of the Peace Process initiative of solid waste under the Working Group on the Environment, with other donor organizations, such as UNDP, and with all performing institutions as grantor. RSED staff will take part in annual planning meetings, and be represented on the Steering Committee as Member, and on the Advisory Committee as the Recorder. RSED Staff, Eileen Herrera and Karleen Peterson, will be assigned to carry out those duties specified.

USDA/ARS Dr. Rufus Chaney, ARS (see Annex II for resumes) will act as consultant and reviewer for the overall technical components of each activity. In addition, ARS will cooperate with Principal Investigators in research activities, offering technical advice and support, providing professional enhancement opportunities (such as laboratory visits) if necessary, and reviewing and providing comments on six-month and annual technical reports, as well as annual plans. Dr. Chaney will also provide assistance with articles and papers for publication, if required. ARS may help to plan an environmental assessment and other technical support as needed.

Ohio State University OSU will provide overall technical coordination from the U.S. side for the project for the composting demonstration sites and economic analysis components, acting as consultant to RSED as well as the regional parties. OSU will assist in the design of surveys and demonstration sites, and provide technical assistance as needed by the regional parties. In addition OSU will review and edit all six-month and annual technical reports to be submitted to A.I.D., as well as provide an executive summary and overall report on the status of activities every six months. This report will be submitted through to A.I.D. In addition, OSU will provide training opportunities for the regional parties (as already described in the workplan) for two persons per regional party per year for up to six months each. These training opportunities will be focused on areas that are either not available in the region or offer the potential for direct experience in an area not currently available in the region. Finally, OSU will provide membership in the Steering Committee. OSU staff: Dr. Harry Hoitink (Technical Leader of the Solid Waste Management - Composting Component) and Dr. Douglas Southgate (Technical Leader of the Solid Waste Economic Assessment Component).

U.S. Environmental Protection Agency EPA will provide input to and participate in the Advisory Committee, assisting in the review of the project from the policy perspective. In addition, EPA will provide training in appropriate areas, such as risk assessment and help to identify and provide resources for composting, recycling, and other relevant solid waste areas. Finally, EPA will assist in the development and review of the

environmental impact assessment of proposed sites.

H. ENVIRONMENTAL IMPACTS

H.1 Assessment of Environmental Impacts

One of the purposes of this project will be to offer viable solutions to the regional parties regarding economically sustainable and environmentally safe management systems for solid waste. The product of this project, properly mature composts, will have the ability to remediate contaminated or saline soils, and reduce the use of soil fumigants when adequate quantities are available. Demonstration sites will initially be set up under controlled conditions for evaluation and for training, both of which render this activity not subject to the procedures set forth in paragraph 216.3 of the International Development Cooperation Agency, Agency for International Development 22 CFR Par 216 Environmental Procedures. However, since continued operation and eventual expansion of operations of the demonstration sites is desirable, the following environmental impact assessment and parameters will be conducted and established at any potential site areas prior to establishing any activities. This environmental impact assessment will also be conducted as a training activity.

A composting facility will provide the required conditions for all-weather composting while also limiting environmental risk, odor and noise. Site selection is a key element in the safe and effective operation of a composting facility. Sites utilized during this project will be investigated to evaluate the attainment of required environmental goals. The selected site will ensure adequate drainage characteristics to prevent excessive pond accumulation, soil saturation and excessive runoff.

The site selection process will involve a baseline environmental impact study encompassing the following:

a. site and area geology
b. site and area soil characteristics
c. site and area hydrology
d. impact analysis to cultural resources
e. assessment impacts of local flood events: 50 and 100 year events
f. assessment of biological impacts
g. assessment of odor impacts and control mechanisms

A complete environmental impact report will be written and assessed by regional experts in consultation with U.S. experts, and according to the guidelines established in *International Development Cooperation Agency, Agency for International Development 22 CFR Par 216 Environmental Procedures.* If possible, concerns of citizens will be addressed in an appropriate forum prior to implementation of any pilot project.

I. Economic analysis.

I.1 Benefit/Cost Analysis.

I.1.1 Development of economic models to evaluate various solid waste management systems will be part of this project. The following is a simplified cost/benefit analysis.

Direct benefits: 1) The availability of better information and decision models that would allow rationale choices that have already been tested; 2) the establishment of a working, field-tested model for composting solid waste; 3) an available pool of trained experts and regional technical linkages to continue implementation and expansion of the models.

Indirect benefits: 1) in the long-term, improved solid waste management systems in the region; 2) potential for continued regional cooperation to address new challenges, problems and technologies as they are manifested.

The problem and proposal in quantitative terms: identification of optimal solid waste management systems that will protect the environment, sustain resources and produce a return (value-added) to the solid waste industry, or - at the very least - minimize the cost of managing solid waste.

Number of people expected to benefit from the project (directly and indirectly). Directly: 15 to 20 persons per regional party through training, collaborative activities or working on the demonstration sites, in addition, approximately 150 persons involved in the solid waste industries in Jordan, the Palestinian Territories and Israel; indirectly: this project would have the potential to affect the lives of all of the inhabitants of Jordan, Israel, and the Palestinian Territories since almost all of the inhabitants are affected to one degree or another by the existing solid waste management systems. However, for the purposes of this evaluation, we will limit the number to the projected number that would be living in the small, rural towns where the demonstration sites would be set up (estimated at 7,000 per town for 2 towns).

Extra costs for extension or educational programs required to get the results of the project to the beneficiaries. No additional costs are associated with the extension of information to the direct beneficiaries that have not been incorporated into this project or that would be covered by other sources. Additional costs would be expected to extend information beyond the sites envisioned.

Comparative cost per beneficiary: $211.27 (approximately $3 million/ 14,200 persons).

Unit cost of the service or product expected to result from the project. This will be specified during the life of the project. The unleveraged cost per pilot project would be estimated at $1.5 million based on the total project cost.

The effects, positive or negative, on the environment. Although the result of this project is anticipated to have an impact on the solid waste management policies of the three regional parties, and therefore, to have a substantial positive impact on the environment, it is unlikely that impact will be measurable in the three years of the project.

I.1.2 Economic Analysis. This model will be applied during the life of the project once the required data has been compiled. Information on the overall cost of the solid waste industry of each regional party - as appropriate to this project, and as will be conducted during the solid waste survey component - will be compiled and analyzed.

I.1.3 A comparative cost-effective analysis (CEA).

Detailed estimated budget for direct & indirect expenses related to the project (see Annex I).

Financial analysis of the institutions involved: (including a breakdown of expenses for administration and overhead vs. the direct expenses for the project, i.e., equipment, commodities, transportation, training, etc.). Include recurrent costs and analyze the ability of participating institutions to pay them. (see Annex I)

Illustrative examples of successful projects completed by proposing institutions and the budgets involved See Annex II for individual resumes and institutional capability statements). Although the individuals and institutions involved have had marked success in the area of composting municipal solid waste and sewage sludges, and although it is anticipated that successful U.S. and Israeli composting enterprises can be cited as successes, this project, because of its inter-regional nature and the lack of adequate infrastructure for solid waste management in the Palestinian Territories, has no comparative parallel project that can be cited. It is known, however, that equivalently-funded projects were undertaken successfully in Brazil and other Latin American countries using low-tech, low-cost inputs and involving local expertise.

Systematic Benefit/Cost. Part of the project will be to conduct an economic analysis, which will include cost/benefit analysis of a variety of management strategies. Correct data must first be systematically gathered, analyzed and compared before an accurate cost/benefit analysis can be made of solid waste management systems.

J. SUSTAINABILITY.

J.1 Sustainability of Two Dimensions: The Project Activity Objective, and the Collaboration of Involved Individual and Institutional Participants.

Sustainability of the project objective. It has been determined that the pilot project to be established in Jordan will be continued after the end of the three year project and maintained by the Ministry of Water and the local municipality. The pilot project in the West Bank will be maintained by the local municipality. Both operations will emphasize achieving economic sustainability from the beginning to the end of the project and will have either achieved a break-even point economically, or will have established a plan to achieve a break-even point over a specified period of time.

Sustainability of collaboration. It is envisioned that the Advisor's Committee would be able to function as the basis for a regional solid waste council by the end of the project. This council would be able to continue to meet periodically and continue to function as a communication link between the technical sector and the policy sector for solid waste management in the region. It is also envisioned that technical linkages established between the Palestinians, Jordanian and Israelis would be easily maintained given the proximity of the groups. This sustainability will largely depend on the establishment of good relationships over the three years of the project, the improvement in and maintenance of capacity of the Palestinian technical sector to continue technical cooperation and the desirability of maintaining the relationships. The project experts believe that, given the nature of the problem in the area, maintaining good technical linkages and continuing to address these problems regionally, rather than just locally, is highly desirable.

J.2 Takeover and Continuation of Project Activities by Local Sources after MERC Support Ends.

As noted in J.1.

J.3 Describe how the collaboration of experts under the project will promote continued association and cooperation after MERC support ends

As noted in J.1.

K. RESOURCE REQUIREMENTS.

K.1 Contributions to Project Budgets from Individual Participating Entities.

As noted in Annex I (Budgets).

K.2 Financial. A Comprehensive Budget Identifying Total Funding by Year and Activity Component and by Sources of Funds.

See Annex I. Quarterly financial reports will be required by all performing institutions and submitted to A.I.D. as required. Financial report formats are included in Annex III.

K.3 Equipment/Commodities.

A procurement plan will be established each year for each performing institution that intends to purchase equipment using MERC funds. This plan will specify the items, cost, source and origin, and estimated date of purchase. Procurements will be reported in the six month reports. All A.I.D. regulations on source and origin of commodities will be followed. Each performing institution's grant agreement will have these requirements included. The requirements will be reiterated in each year's procurement plan.

Specific equipment to be purchased will be identified during the first six months to one year of the project since a cost-benefit analysis will identify the best type of composting system to use. It is likely, however, that such equipment may include a shredder, a windrows turner, aeration (blowers, hoses, etc.), materials to construct a closed system, a truck for transportation of materials, monitoring and analysis equipment (e.g., computers, spectophotometer, etc).

L. EVALUATION AND AUDIT.

L.1 Principal Objectives to be Achieved by the Project and the Indicators of Progress for Evaluation.

The project's goal was stated: to improve of the capabilities of all three regional parties to devise and/or improve solid waste management strategies, and to establish a basis for regional cooperation in management of solid waste. Specific objectives and corresponding indicators are:

1. Objective: The participating organizations of this project will examine, analyze, and - where possible - implement environmentally safe and economically sustainable solid waste management technologies, with a focus on composting of municipal solid waste and sewage sludge.

Indicator(s): successfully operating pilot projects; implementation of new technologies and strategies in the region; a valid, well written report on the environmental impact of the pilot projects on the environment; establishment of a reference database in which all regional parties will have established a baseline of data; steady progress through the life of the project as indicated by the reports.

2. Objective: The participating experts of this project will devise strategies relevant to Middle Eastern municipalities, emphasizing value added approaches (such as

composting, sorting and recycling), private sector development, and non-governmental organization (NGO) strengthening.

Indicator(s): well supported, written strategies delivered to responsible policy makers in the region; manifested interest by policy makers in the strategies presented; good level of participation in the project by NGO's and private sector (or municipal groups responsible for solid waste management).

3. Objective: This project will establish organizational linkages with current and future programs designed to develop and improve infrastructure in the region.

Indicator(s): Facility and ease of information exchange between project experts; willingness of the project participants to find mechanisms to continue cooperation.

4. Objective: The project will support and assist the development of technical efforts at the municipal and rural level, leading to suitable models for management of MSW and sewage sludge under arid conditions in various economic settings that will have immediate relevance for policy makers.

Indicator(s): regional experts are able to design, implement, operate and manage a composting operation; regional experts are able to compile and analyze information and make decisions under a variety of factors with regards to solid waste management; regional experts are able to convince policy makers to modify policies, undertake new technologies, or otherwise have an impact on the decision-making process.

L.2 How the Project should be Evaluated and How the Results will be Disseminated.

The project should be evaluated by one regional and developmental expert, preferably a Sociologist and one solid waste management expert well versed in small municipal composting systems. The first (midterm) evaluation should take place at the end of the second year when most of the data will have been collected, systems and sites will have been evaluated, and the full pilot project plans will be finalized for implementation. A final evaluation may take place at the end of the project time frame, but could be conducted by the local A.I.D. offices with the assistance of one or more local solid waste-composting experts.

The evaluations would examine whether objectives had been met, whether changes had been made, and if so, how the decisions were arrived at. In addition, the evaluators could examine the relationships of the project participants, the level of communication in the various groups and committees. In addition, the evaluators could visit the proposed sites and discuss the projects with local municipal leaders and other local inhabitants to gage their general reaction to the project. Finally, the evaluators could visit local policy makers and gage their reactions to the recommendations coming from this project, their receptivity to these recommendations, and to what extent these recommendations may be implemented.

L.3 Applicability of USAID Regulations, Including Audit Requirements

All subgrantees will be subject to A.I.D. regulations, including audit requirements. This clause and the corresponding description will be added to all sub-agreements under this project by USDA.

M. Reports.

M.1 Annual Workplans, Quarterly Financial Reports, and Semi-Annual Progress Reports (see Annex III for report formats)

As already discussed, an annual plan will be developed each year during planning (Steering Committee) meetings, using the objectives stated in this proposal as guidelines. The first one will be held at the beginning of the project (which would likely be in late Summer or Fall of 1995). The plan would include specific objectives for each activity as related to those delineated in this proposal, a detailed workplan, progress markers for each activity in the workplan, and time frame when the activities would be expected to be carried out. After the first six months of each year, each group would write a report relating to each activity (data/survey of solid waste, training, demonstration site development and implementation, etc.):

--a description of each activity (individuals involved, what was conducted, how it was conducted)
--progress markers met, or those that were not met,
--problems encountered
--brief analysis and/or recommendations for improving the activity
--projection of activities for the next six months.

The reports may be written and submitted by each regional party or in combination depending on whether that activity was conducted solely by each party or together.

After the second six months of each year, an annual report would be developed, prior to or during the next Steering Committee Meeting. This report would incorporate the first six month report, add any additional information with regards to additional progress in the subsequent six months, and add:

--a more indepth analysis of what was accomplished during the year;
--a list of any publications, presentations, events, travel or changes that occurred as a result of this project (e.g., changes in solid waste collection systems, public awareness campaigns, etc.);
--a plan for the next year's activities as described above. Should anything in the current workplan be recommended for modification, the rationale and modified plan will be included in the report.

As noted, financial reports will be submitted quarterly by all performing institutions.

M.2 Development of Workplans and Monitoring of Programs

As noted above in M.1.

M.3 Development of Semi-Annual Reports that Portray the Progress of the Project Toward Reaching Each Objective.

As noted above in M.1.

M.4 Describe how expenditures will be tracked and reported.

USDA/FAS/ICD/RSED obligates and dispenses funds in accordance with U.S. Federal regulations using the National Finance Center, New Orleans, LA for general accounting. RSED has managed three other projects with A.I.D. under the MERC and several other projects for A.I.D. Cairo, Delhi, Bangkok and Washington. USDA would issue sub-grant agreements to performing institutions in the U.S. and abroad.

Each institution with a sub-grant agreement will be responsible for tracking and reporting expenditures using the format in Appendix III. Institutions with no experience in managing A.I.D. or other U.S. Government funded projects in the recent past will be required to describe in detail their accounting system, describe in detail how they will manage funds - including keeping receipts, formal records of all transactions in English, and requiring the signature of the Project Technical Leader for that institution to obligate funds.

N. TECHNICAL ANTECEDENTS.

N.1 Other Sponsors or other USAID Offices Sponsoring this Project.

To the best of our knowledge, this project does not duplicate the efforts of any other donor. In fact, this project and the participants will do their best to ensure coordination with other efforts in the same area to maximize impact and increase resources. A complementary project has been submitted to the U.S.E.P.A. under the Environmental Technology Initiative that would strengthen linkages with the U.S. private sector in this area. The Government of Italy will likely sponsor a project to fund a pilot solid waste management system in the West Bank. UNDP will likely fund solid waste projects in the West Bank and Gaza. USDA and the project participants will coordinate with these organizations and any other projects in this area that are brought to our attention.

ANNEX I

PROJECT BUDGETS
BY ACTIVITY AND BY INSTITUTION

Institutional Cost-Benefit Analalysis			
Institution	Admin & O	Other costs	Ratio
1. Israel: Technion	31,440	163,500	19.23%
2. Israel: Hebrew Univ.	50,500	149,000	33.89%
3. PNA: Al Najah, et al	78,000	264,000	29.55%
4. Jordan: MIW, Jordan Uni	39,870	211,500	18.85%
5. Ohio State University	62,974	295,661	21.30%
6. USDA	270,745	2,371,592	11.42%
7. Unassigned	91,000	596,900	15.25%
Note: Ohio State and USDA components not to be sustainable after the end of the project.			
Jordanian, Palestinian and Israeli components will be able to be continued as described			
in the proposal. MERC funds request analyzed only. Contributions from performing			
institutions is not considered. In addition, contributions from complementary programs were			
not considered. USDA based on total volume of project.			

BUDGET FOR PROJECT (MERC FUNDS REQUESTED)								
	'Year 1		'Year 2		'Year 3		'Total	
SUMMARY BUDGET	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind
Activities								
1. Data, survey & evaluation	132,100	40,200	132,100	40,200	132,600	40,200	396,800	120,600
2. Econ & Mkt Analysis	98,900	21,800	97,900	21,800	97,900	21,800	294,700	65,400
3. Training (regional and U.S.)	87,300	0	87,300	0	87,300	0	261,900	0
4. 2 Demo sites & Tech Trans	337,000	12,000	411,000	12,000	237,000	15,000	985,000	39,000
5. Technology Improvement	63,000	25,000	62,000	25,000	50,000	29,000	175,000	79,000
6. U.S. travel & participation	86,064	43,951	86,064	43,951	86,064	43,951	258,192	131,853
7. Total Direct Costs	804,364	142,951	876,364	142,951	690,864	149,951	2,371,592	435,853
8. Total Overhead (25%)	201,091	0	219,091	0	172,716	0	592,898	0
9. Total Direct Costs & Overhea	1,005,455	142,951	1,095,455	142,951	863,580	149,951	2,964,490	435,853

BUDGET FOR 1. DATA SURVEY & EVALUATION: SUMMARY								
Institutions: All	'Year 1		'Year 2		'Year 3		'Total	
_____	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind
1. Personnel								
Technical Leader (_____%) x ?	4,300	16,100	4,300	16,100	4,300	16,100	12,900	48,300
Technicians/Scientists f							0	0
on staff (_____%) x ?	22,600	24,100	22,600	24,100	22,600	24,100	67,800	72,300
Research Assistant/Field							0	0
Personnel (_____%) x ?	30,200	0	30,200	0	30,200	0	90,600	0
Support Staff (____%) x ?	8,000	0	8,000	0	8,000	0	24,000	0
Subtotal:	65,100	40,200	65,100	40,200	65,100	40,200	195,300	120,600
2. Travel - Regional/Local	12,000	0	12,000	0	12,000	0	36,000	0
3. Travel - Other	12,000	0	12,000	0	12,000	0	36,000	0
4. Supplies/expendable materials	16,000	0	16,000	0	16,000	0	48,000	0
5. Equipment (depreciable - list)								
a.	19,000	0	19,000	0	19,000	0	57,000	0
b.	0	0	0	0	0	0	0	0
c.	0	0	0	0	0	0	0	0
d.	0	0	0	0	0	0	0	0
Subtotal equip. costs:	19,000	0	19,000	0	19,000	0	57,000	0
6. Other miscellaneous (list)								
a. Publications	8,000	0	8,000	0	8,500	0	24,500	0
b.	0	0	0	0	0	0	0	0
c.	0	0	0	0	0	0	0	0
Subtotal Misc Costs:	8,000	0	8,000	0	8,500	0	24,500	0
7. Subtotal Direct Costs:	132,100	40,200	132,100	40,200	132,600	40,200	396,800	120,600
8. Overhead (14% - MERC)	18,494		18,494		18,564		55,552	
9. Total Direct & Indirect Costs:	150,594	40,200	150,594	40,200	151,164	40,200	452,352	120,600

BUDGET FOR 1. DATA SURVEY & EVALUATION: Israel								
Institution: Technion	'Year 1		'Year 2		'Year 3		'Total	
	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind
1. Personnel							0	0
Technical Leader (15%) x 1	1,800	3,600	1,800	3,600	1,800	3,600		
Technicians/Scientists							0	0
on staff (50%) x 1	12,600	12,600	12,600	12,600	12,600	12,600	37,800	37,800
Research Assistant/Field							0	0
Personnel (40%) x 1	7,200		7,200		7,200		21,600	0
Support Staff (____%) x 0							0	0
Subtotal:	21,600	16,200	21,600	16,200	21,600	16,200	64,800	48,600
2. Travel - Regional/Local	2,000		2,000		2,000		6,000	0
3. Travel - Other	4,500		4,500		4,500		13,500	0
4. Supplies/expendable materials	1,000		1,000		1,000		3,000	0
5. Equipment (depreciable - list)								
a.							0	0
b.							0	0
c.							0	0
d.							0	0
Subtotal equip. costs:	0	0	0	0	0	0	0	0
6. Other miscellaneous (list)								
a. Publications	1,000		1,000		1,000		3,000	0
b.							0	0
c.							0	0
Subtotal Misc Costs:	1,000	0	1,000	0	1,000	0	3,000	0
7. Subtotal Direct Costs:	30,100	16,200	30,100	16,200	30,100	16,200	90,300	48,600
8. Overhead (14% - MERC)	4,214		4,214		4,214		12,642	
9. Total Direct & Indirect Co	34,314	16,200	34,314	16,200	34,314	16,200	102,942	48,600

BUDGET FOR 1. DATA SURVEY & EVALUATION: PNA								
Institution: Al Najah Univ.	'Year 1		'Year 2		'Year 3		'Total	
	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind
1. Personnel							0	0
Technical Leader (10%) x 1	2,500	10,000	2,500	10,000	2,500	10,000		
Technicians/Scientists f							0	0
on staff (50%) x 2	10,000	10,000	10,000	10,000	10,000	10,000	30,000	30,000
Research Assistant/Field							0	0
Personnel (100%) x 5	20,000		20,000		20,000		60,000	0
Support Staff (100%) x 2	8,000		8,000		8,000		24,000	0
Subtotal:	40,500	20,000	40,500	20,000	40,500	20,000	121,500	60,000
2. Travel - Regional/Local	5,000		5,000		5,000		15,000	0
3. Travel - Other	2,500		2,500		2,500		7,500	0
4. Supplies/expendable materials	5,000		5,000		5,000		15,000	0
5. Equipment (depreciable - list)								
a. Computer, printer, appl	9,500		9,500		9,500		28,500	0
b.	0		0		0		0	0
c.	0		0		0		0	0
d.							0	0
Subtotal equip. costs:	9,500	0	9,500	0	9,500	0	28,500	0
6. Other miscellaneous (list)								
a. Publications	4,000		4,000		4,500		12,500	0
b.							0	0
c.							0	0
Subtotal Misc Costs:	4,000	0	4,000	0	4,500	0	12,500	0
7. Subtotal Direct Costs:	66,500	20,000	66,500	20,000	67,000	20,000	200,000	60,000
8. Overhead (14% - MERC)	9,310		9,310		9,380		28,000	
9. Total Direct & Indirect Co	75,810	20,000	75,810	20,000	76,380	20,000	228,000	60,000

BUDGET FOR 1. DATA SURVEY & EVALUATION: Jordan								
Institution: Ministry of Water	'Year 1		'Year 2		'Year 3		'Total	
	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind
1. Personnel							0	0
Technical Leader (10%) x 1		2,500		2,500		2,500		
Technicians/Scientists							0	0
on staff (10%) x 1		1,500		1,500		1,500	0	4,500
Research Assistant/Field							0	0
Personnel (10%) x 5	3,000		3,000		3,000		9,000	0
Support Staff (____%) x ?							0	0
Subtotal:	3,000	4,000	3,000	4,000	3,000	4,000	9,000	12,000
2. Travel - Regional/Local	5,000		5,000		5,000		15,000	0
3. Travel - Other	5,000		5,000		5,000		15,000	0
4. Supplies/expendable materials	10,000		10,000		10,000		30,000	0
5. Equipment (depreciable - list)								
a. Computer, printer, appli's	9,500		9,500		9,500		28,500	0
b.							0	0
c.							0	0
d.							0	0
Subtotal equip. costs:	9,500	0	9,500	0	9,500	0	28,500	0
6. Other miscellaneous (list)								
a. Publications	3,000		3,000		3,000		9,000	0
b.							0	0
c.							0	0
Subtotal Misc Costs:	3,000	0	3,000	0	3,000	0	9,000	0
7. Subtotal Direct Costs:	35,500	4,000	35,500	4,000	35,500	4,000	106,500	12,000
8. Overhead (14% - MERC)	4,970		4,970		4,970		14,910	
9. Total Direct & Indirect Co	40,470	4,000	40,470	4,000	40,470	4,000	121,410	12,000

BUDGET FOR 2. ECONOMIC & MARKET ANALYSIS: SUMMARY								
Institutions: All	'Year 1		'Year 2		'Year 3		'Total	
	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind
1. Personnel								
Technical Leader (_____%) x ?	6,200	10,400	6,200	10,400	6,200	10,400	18,600	31,200
Administrative Leader (_____%)	0	0	0	0	0	0	0	0
Admin staff (_____%) x ?	8,400	10,400	8,400	10,400	8,400	10,400	25,200	31,200
Research Assistant/Field							0	0
Personnel (_____%) x ?	11,300	0	11,300	0	11,300	0	33,900	0
Support Staff (____%) x ?	8,500	0	8,500	0	8,500	0	25,500	0
Subtotal:	34,400	20,800	34,400	20,800	34,400	20,800	103,200	62,400
2. Travel - Regional/Local	10,000	1,000	10,000	1,000	10,000	1,000	30,000	3,000
3. Travel - Other	15,000	0	15,000	0	15,000	0	45,000	0
4. Supplies/expendable materials	18,000	0	18,000	0	18,000	0	54,000	0
5. Equipment (depreciable - list)								
a.	9,500	0	9,500	0	9,500	0	28,500	0
b.	0	0	0	0	0	0	0	0
c.	0	0	0	0	0	0	0	0
d.	0	0	0	0	0	0	0	0
Subtotal equip. costs:	9,500	0	9,500	0	9,500	0	28,500	0
6. Other miscellaneous (list)								
a. Publications	12,000	0	11,000	0	11,000	0	34,000	0
b.	0	0	0	0	0	0	0	0
c.	0	0	0	0	0	0	0	0
Subtotal Misc Costs:	12,000	0	11,000	0	11,000	0	34,000	0
7. Subtotal Direct Costs:	98,900	21,800	97,900	21,800	97,900	21,800	294,700	65,400
8. Overhead (14% - MERC)	13,846		13,706		13,706		41,258	
9. Total Direct & Indirect Costs:	112,746	21,800	111,606	21,800	111,606	21,800	335,958	65,400

BUDGET FOR 2. ECONOMIC & MARKET ANALYSIS: Israel								
Institution: Technion	'Year 1		'Year 2		'Year 3		'Total	
_____	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind
1. Personnel								
Technical Leader (15%) x 1	1,200	2,400	1,200	2,400	1,200	2,400	3,600	7,200
Technicians/Scientists							0	0
on staff (50%) x 1)	8,400	8,400	8,400	8,400	8,400	8,400	25,200	25,200
Research Assistant/Field							0	0
Personnel (40%) x 1	4,800		4,800		4,800		14,400	0
Support Staff (____%) x 1	2,500		2,500		2,500		7,500	0
Subtotal:	16,900	10,800	16,900	10,800	16,900	10,800	50,700	32,400
2. Travel - Regional/Local	2,000		2,000		2,000		6,000	0
3. Travel - Other	5,000		5,000		5,000		15,000	0
4. Supplies/expendable materials	3,000		3,000		3,000		9,000	0
5. Equipment (depreciable - list)								
a.							0	0
b.							0	0
c.							0	0
d.							0	0
Subtotal equip. costs:	0	0	0	0	0	0	0	0
6. Other miscellaneous (list)								
a. Publications							0	0
b.							0	0
c.							0	0
Subtotal Misc Costs:	0	0	0	0	0	0	0	0
7. Subtotal Direct Costs:	26,900	10,800	26,900	10,800	26,900	10,800	80,700	32,400
8. Overhead (14% - MERC)	3,766		3,766		3,766		11,298	
9. Total Direct & Indirect Co	30,666	10,800	30,666	10,800	30,666	10,800	91,998	32,400

BUDGET FOR 2. ECONOMIC & MARKET ANALYSIS: PNA								
Institution: Al Najah University	'Year 1		'Year 2		'Year 3		'Total	
	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind
1. Personnel							0	0
Technical Leader (25%) x 1	5,000	5,000	5,000	5,000	5,000	5,000		
Technicians/Scientists f							0	0
on staff (_____%) x ?							0	0
Research Assistant/Field							0	0
Personnel (100%) x 1	4,000		4,000		4,000		12,000	0
Support Staff 50%) x 1	3,000		3,000		3,000		9,000	0
Subtotal:	12,000	5,000	12,000	5,000	12,000	5,000	36,000	15,000
2. Travel - Regional/Local	5,000	1,000	5,000	1,000	5,000	1,000	15,000	3,000
3. Travel - Other	5,000		5,000		5,000		15,000	0
4. Supplies/expendable materials	5,000		5,000		5,000		15,000	0
5. Equipment (depreciable - list)								
a.							0	0
b.							0	0
c.							0	0
d.							0	0
Subtotal equip. costs:	0	0	0	0	0	0	0	0
6. Other miscellaneous (list)								
a. Publications	7,000		6,000		6,000		19,000	0
b.							0	0
c.							0	0
Subtotal Misc Costs:	7,000	0	6,000	0	6,000	0	19,000	0
7. Subtotal Direct Costs:	34,000	6,000	33,000	6,000	33,000	6,000	100,000	18,000
8. Overhead (14% - MERC)	4,760		4,620		4,620		14,000	
9. Total Direct & Indirect Co	38,760	6,000	37,620	6,000	37,620	6,000	114,000	18,000

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BUDGET FOR 2. ECONOMIC & MARKET ANALYSIS: JORDAN								
Institution: Jordan University	'Year 1		'Year 2		'Year 3		'Total	
	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind
1. Personnel							0	0
Technical Leader (15%) x 1		3,000		3,000		3,000		
Technicians/Scientists							0	0
on staff (10%) x 1		2,000		2,000		2,000	0	6,000
Research Assistant/Field							0	0
Personnel (50%) x 1	2,500		2,500		2,500		7,500	0
Support Staff (25%) x 1	3,000		3,000		3,000		9,000	0
Subtotal:	5,500	5,000	5,500	5,000	5,500	5,000	16,500	15,000
2. Travel - Regional/Local	3,000		3,000		3,000		9,000	0
3. Travel - Other	5,000		5,000		5,000		15,000	0
4. Supplies/expendable materials	10,000		10,000		10,000		30,000	0
5. Equipment (depreciable - list)								
a. Computer, printer, appl	9,500		9,500		9,500		28,500	0
b.							0	0
c.							0	0
d.							0	0
Subtotal equip. costs:	9,500	0	9,500	0	9,500	0	28,500	0
6. Other miscellaneous (list)								
a. Publications	5,000		5,000		5,000		15,000	0
b.							0	0
c.							0	0
Subtotal Misc Costs:	5,000	0	5,000	0	5,000	0	15,000	0
7. Subtotal Direct Costs:	38,000	5,000	38,000	5,000	38,000	5,000	114,000	15,000
8. Overhead (14% - MERC)	5,320		5,320		5,320		15,960	
9. Total Direct & Indirect Co	43,320	5,000	43,320	5,000	43,320	5,000	129,960	15,000

BUDGET FOR 3. TRAINING/PROF. DEVELOPMENT: SUMMARY								
Institutions: *All*	'Year 1		'Year 2		'Year 3		'Total	
	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind
1. Personnel								
--Already allocated within other							0	0
other budgets							0	0
							0	0
							0	0
							0	0
							0	0
Subtotal:	0	0	0	0	0	0	0	0
2. Travel to & in the U.S.	35,500	0	35,500	0	35,500	0	106,500	0
3. Maintenance in the U.S.	28,800	0	28,800	0	28,800	0	86,400	0
(3 persons for 6 months per yr).								
4. Supplies/expendable materials	10,000	0	10,000	0	10,000	0	30,000	0
5. Equipment (depreciable - list)								
a.	0	0	0	0	0	0	0	0
b.	0	0	0	0	0	0	0	0
c.	0	0	0	0	0	0	0	0
d.	0	0	0	0	0	0	0	0
Subtotal equip. costs:	0	0	0	0	0	0	0	0
6. Other miscellaneous (list)								
a. Publications	13,000	0	13,000	0	13,000	0	39,000	0
b.	0	0	0	0	0	0	0	0
c.	0	0	0	0	0	0	0	0
Subtotal Misc Costs:	13,000	0	13,000	0	13,000	0	39,000	0
7. Subtotal Direct Costs:	87,300	0	87,300	0	87,300	0	261,900	0
8. Overhead (14% - MERC)	12,222		12,222		12,222		36,666	
9. Total Direct & Indirect Costs:	99,522	0	99,522	0	99,522	0	298,566	0

BUDGET FOR 3. TRAINING/PROF. DEVELOPMENT IN THE U.S.								
Institution: All Regional Institution	'Year 1		'Year 2		'Year 3		'Total	
Managed by Ohio State Univ.	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind
1. Personnel							0	0
--Already allocated within other								
other budgets							0	0
							0	0
							0	0
							0	0
							0	0
Subtotal:	0	0	0	0	0	0	0	0
2. Travel to & in the U.S.	10,500		10,500		10,500		31,500	0
3. Maintenance in the U.S.	28,800		28,800		28,800		86,400	0
(3 persons for 6 months per yr).								
4. Supplies/expendable materials							0	0
5. Equipment (depreciable - list)								
a.							0	0
b.							0	0
c.							0	0
d.							0	0
Subtotal equip. costs:	0	0	0	0	0	0	0	0
6. Other miscellaneous (list)								
a. Publications	3,000		3,000		3,000		9,000	0
b.							0	0
c.							0	0
Subtotal Misc Costs:	3,000	0	3,000	0	3,000	0	9,000	0
7. Subtotal Direct Costs:	42,300	0	42,300	0	42,300	0	126,900	0
8. Overhead (14% - MERC)	5,922		5,922		5,922		17,766	
9. Total Direct & Indirect Co	48,222	0	48,222	0	48,222	0	144,666	0

BUDGET FOR 3. TRAINING/PROF. DEVELOPMENT IN THE REGION								
Institutions: (all regional	'Year 1		'Year 2		'Year 3		'Total	
participants)	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind
1. Personnel							0	0
Technical Leader (_____%) x ?								
Technicians/Scientists f							0	0
on staff (_____%) x ?							0	0
Research Assistant/Field							0	0
Personnel (40%) x 1	10,000		10,000		10,000		30,000	0
Support Staff (____%) x ?							0	0
Subtotal:	10,000	0	10,000	0	10,000	0	30,000	0
2. Travel - Regional/Local	25,000		25,000		25,000		75,000	0
3. Travel - Other							0	0
4. Supplies/expendable materials	10,000		10,000		10,000		30,000	0
5. Equipment (depreciable - list)								
a.							0	0
b.							0	0
c.							0	0
d.							0	0
Subtotal equip. costs:	0	0	0	0	0	0	0	0
6. Other miscellaneous (list)								
a. Publications	10,000		10,000		10,000		30,000	0
b.							0	0
c.							0	0
Subtotal Misc Costs:	10,000	0	10,000	0	10,000	0	30,000	0
7. Subtotal Direct Costs:	55,000	0	55,000	0	55,000	0	165,000	0
8. Overhead (14% - MERC)	7,700		7,700		7,700		23,100	
9. Total Direct & Indirect Co	62,700	0	62,700	0	62,700	0	188,100	0

BUDGET FOR 4. RAPID TECH TRANSFER & DEMONSTRATION SITES: SUMMARY								
Institutions: All	'Year 1		'Year 2		'Year 3		'Total	
_____	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind
1. Personnel								
Technical Leader (_____%) x ?	2,000	0	2,000	0	2,000	0	0	0
Technicians/Scientists f	0	0	0	0	0	0	0	0
on staff (_____%) x ?	0	0	8,000	0	8,000	3,000	16,000	3,000
Research Assistant/Field							0	0
Personnel (_____%) x ?	21,000	8,000	36,000	8,000	36,000	8,000	93,000	24,000
Support Staff (____%) x ?	11,000	4,000	14,000	4,000	14,000	4,000	39,000	12,000
Subtotal:	34,000	12,000	60,000	12,000	60,000	15,000	154,000	39,000
2. Travel - Regional/Local	15,000	0	15,000	0	15,000	0	45,000	0
3. Travel - Other	10,000	0	10,000	0	10,000	0	30,000	0
4. Supplies/expendable materials	18,000	0	20,000	0	25,000	0	63,000	0
5. Equipment (depreciable - list)								
a.	175,000	0	0	0	0	0	175,000	0
b.	75,000	0	85,000	0	0	0	160,000	0
c.	0	0	200,000	0	0	0	200,000	0
d.	0	0	0	0	100,000	0	100,000	0
Subtotal equip. costs:	250,000	0	285,000	0	100,000	0	635,000	0
6. Other miscellaneous (list)								
a. Publications	10,000	0	10,000	0	15,000	0	35,000	0
b.	0	0	11,000	0	12,000	0	23,000	0
c.	0	0	0	0	0	0	0	0
Subtotal Misc Costs:	10,000	0	21,000	0	27,000	0	58,000	0
7. Subtotal Direct Costs:	337,000	12,000	411,000	12,000	237,000	15,000	985,000	39,000
8. Overhead (14% - MERC)	47,180		57,540		33,180		137,900	
9. Total Direct & Indirect Costs:	384,180	12,000	468,540	12,000	270,180	15,000	1,122,900	39,000

BUDGET FOR 4. RAPID TECH TRANSFER & DEMONSTRATION SITES: WEST BANK								
Institutions: various regional	'Year 1		'Year 2		'Year 3		'Total	
institutions (1)	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind
1. Personnel							0	0
Tech. Leader (10%) x 1	2,000		2,000		2,000			
Plant Manager							0	0
on staff (100%) x 1			8,000		8,000	3,000	16,000	3,000
Research Assistant/Field							0	0
Personnel (100%) x 5	5,000		20,000		20,000		45,000	0
Support Staff (100%) x 2	3,000		6,000		6,000		15,000	0
Subtotal:	10,000	0	36,000	0	36,000	3,000	82,000	3,000
2. Travel - Regional/Local	5,000		5,000		5,000		15,000	0
3. Travel - Other	5,000		5,000		5,000		15,000	0
4. Supplies/expendable materials	8,000		10,000		15,000		33,000	0
5. Equipment (depreciable - list)								
a. Transport for solid waste	75,000						75,000	0
b. Shredding equipment	40,000						40,000	0
c. Sorting/turning equipment			100,000				100,000	0
d. Monitoring equipment					100,000		100,000	0
Subtotal equip. costs:	115,000	0	100,000	0	100,000	0	315,000	0
6. Other miscellaneous (list)								
a. Packaging materials	5,000		5,000		10,000		20,000	0
b. On-Farm demonstration mat.					5,000		5,000	0
c.							0	0
Subtotal Misc Costs:	5,000	0	5,000	0	15,000	0	25,000	0
7. Subtotal Direct Costs:	148,000	0	161,000	0	176,000	3,000	485,000	3,000
8. Overhead (14% - MERC)	20,720		22,540		24,640		67,900	
9. Total Direct & Indirect Co	168,720	0	183,540	0	200,640	3,000	552,900	3,000

(1) Institutions to be determined when final implementation plan has been developed and approved by the Steering Commitee, likely Al-Najah Univ and OSU will manage.

BUDGET FOR 4. RAPID TECH TRANSFER & DEMONSTRATION SITES: Jordan								
Institution: Various	'Year 1		'Year 2		'Year 3		'Total	
_____	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind
1. Personnel							0	0
Technical Leader (_____%) x ?								
Technicians/Scientists f							0	0
on staff (_____%) x ?							0	0
Research Assistant/Field							0	0
Personnel (50%) x 4	16,000	8,000	16,000	8,000	16,000	8,000	48,000	24,000
Support Staff (100%) x 1	8,000	4,000	8,000	4,000	8,000	4,000	24,000	12,000
Subtotal:	24,000	12,000	24,000	12,000	24,000	12,000	72,000	36,000
2. Travel - Regional/Local	10,000		10,000		10,000		30,000	0
3. Travel - Other	5,000		5,000		5,000		15,000	0
4. Supplies/expendable materials	10,000		10,000		10,000		30,000	0
5. Equipment (depreciable - list)								
a. Turning equipment	100,000						100,000	0
b. Monitoring equipment	35,000		85,000				120,000	0
c. Aeration equipment			100,000				100,000	0
d.							0	0
Subtotal equip. costs:	135,000	0	185,000	0	0	0	320,000	0
6. Other miscellaneous (list)								
a. Publications	5,000		5,000		5,000		15,000	0
b. Packaging			11,000		7,000		18,000	0
c.							0	0
Subtotal Misc Costs:	5,000	0	16,000	0	12,000	0	33,000	0
7. Subtotal Direct Costs:	189,000	12,000	250,000	12,000	61,000	12,000	500,000	36,000
8. Overhead (14% - MERC)	26,460		35,000		8,540		70,000	
9. Total Direct & Indirect Co	215,460	12,000	285,000	12,000	69,540	12,000	570,000	36,000

BUDGET FOR 5. TECHNOLOGY IMPROVEMENT: SUMMARY								
Institutions: All	'Year 1		'Year 2		'Year 3		'Total	
_____	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind
1. Personnel								
Technical Leader (_____%) x ?	0	0	0	0	0	0	0	0
Technicians/Scientists f	0	0	0	0	0	0	0	0
on staff (_____%) x ?	20,000	20,000	20,000	20,000	20,000	20,000	60,000	60,000
Research Assistant/Field							0	0
Personnel (_____%) x ?	0	0	0	0	0	0	0	0
Support Staff (____%) x ?	10,000	5,000	10,000	5,000	6,000	9,000	26,000	19,000
Subtotal:	30,000	25,000	30,000	25,000	26,000	29,000	86,000	79,000
2. Travel - Regional/Local	9,000	0	9,000	0	5,000	0	23,000	0
3. Travel - Other	0	0	0	0	0	0	0	0
4. Supplies/expendable materials	10,000	0	10,000	0	8,000	0	28,000	0
5. Equipment (depreciable - list)								
a.	0	0	0	0	0	0	0	0
b.	0	0	0	0	0	0	0	0
c.	0	0	0	0	0	0	0	0
d.	0	0	0	0	0	0	0	0
Subtotal equip. costs:	0	0	0	0	0	0	0	0
6. Other miscellaneous (list)								
a. Publications	2,000	0	2,000	0	3,000	0	7,000	0
b.	9,000	0	8,000	0	6,000	0	23,000	0
c.	3,000	0	3,000	0	2,000	0	8,000	0
Subtotal Misc Costs:	14,000	0	13,000	0	11,000	0	38,000	0
7. Subtotal Direct Costs:	63,000	25,000	62,000	25,000	50,000	29,000	175,000	79,000
8. Overhead (14% - MERC)	8,820		8,680		7,000		24,500	
9. Total Direct & Indirect Costs:	71,820	25,000	70,680	25,000	57,000	29,000	199,500	79,000

BUDGET FOR 5. TECHNOLOGY IMPROVEMENT								
Institution: Hebrew University	'Year 1		'Year 2		'Year 3		'Total	
Faculty of Agriculture	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind
1. Personnel							0	0
Technical Leader (_____%) x 2								
Technicians/Scientists f							0	0
on staff (50%) x 1	20,000	20,000	20,000	20,000	20,000	20,000	60,000	60,000
Research Assistant/Field							0	0
Personnel (_____%) x ?							0	0
Support Staff (____%) x 1	10,000	5,000	10,000	5,000	6,000	9,000	26,000	19,000
Subtotal:	30,000	25,000	30,000	25,000	26,000	29,000	86,000	79,000
2. Travel - Regional/Local	9,000		9,000		5,000		23,000	0
3. Travel - Other	0		0		0		0	0
4. Supplies/expendable materials	10,000		10,000		8,000		28,000	0
5. Equipment (depreciable - list)								
a.							0	0
b.							0	0
c.							0	0
d.							0	0
Subtotal equip. costs:	0	0	0	0	0	0	0	0
6. Other miscellaneous (list)								
a. Publications	2,000		2,000		3,000		7,000	0
b. Analytical Services	9,000		8,000		6,000		23,000	0
c. Computer Services	3,000		3,000		2,000		8,000	0
Subtotal Misc Costs:	14,000	0	13,000	0	11,000	0	38,000	0
7. Subtotal Direct Costs:	63,000	25,000	62,000	25,000	50,000	29,000	175,000	79,000
8. Overhead (14% - MERC)	8,820		8,680		7,000		24,500	
9. Total Direct & Indirect Co	71,820	25,000	70,680	25,000	57,000	29,000	199,500	79,000

BUDGET FOR 6. U.S. PARTICIPATION: SUMMARY								
Institutions: All	'Year 1		'Year 2		'Year 3		'Total	
	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind
1. Personnel								
Technical Leaders	0	24,235	0	24,235	0	24,235	0	72,705
Technicians/Scientists	0	0	0	0	0	0	0	0
on staff	31,552	0	31,552	0	31,552	0	94,656	0
Research Assistant/Field							0	0
Personnel	16,512	9,168	16,512	9,168	16,512	9,168	49,536	27,504
Support Staff	0	3,048	0	3,048	0	3,048	0	9,144
Subtotal:	48,064	36,451	48,064	36,451	48,064	36,451	144,192	109,353
2. Travel - Regional/Local	22,000	0	22,000	0	22,000	0	66,000	0
3. Travel - Other	2,000	1,000	2,000	1,000	2,000	1,000	6,000	3,000
4. Supplies/expendable materials	13,500	6,000	13,500	6,000	13,500	6,000	40,500	18,000
5. Equipment (depreciable - list)								
a.	0	0	0	0	0	0	0	0
b.	0	0	0	0	0	0	0	0
c.	0	0	0	0	0	0	0	0
d.	0	0	0	0	0	0	0	0
Subtotal equip. costs:	0	0	0	0	0	0	0	0
6. Other miscellaneous (list)								
a. Publications	500	500	500	500	500	500	1,500	1,500
b.	0	0	0	0	0	0	0	0
c.	0	0	0	0	0	0	0	0
Subtotal Misc Costs:	500	500	500	500	500	500	1,500	1,500
7. Subtotal Direct Costs:	86,064	43,951	86,064	43,951	86,064	43,951	258,192	131,853
8. Overhead (OSU, ARS)	100,529	0	108,449	0	88,044	0	297,022	0
9. Overhead (ICD Retained)	90,650		98,570		78,165		267,385	0
10. Total Direct & Indirect Costs:	186,593	43,951	194,513	43,951	174,108	43,951	555,214	131,853

BUDGET FOR 6. U.S. PARTICIPATION								
Institution: Ohio State University	'Year 1		'Year 2		'Year 3		'Total	
	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind	MERC	Other/In-kind
1. Personnel								0
Technical Leader (10%) x 2		15,360		15,360		15,360	0	46,080
Program Coordinator							0	0
(100%) x 1	31,552		31,552		31,552		94,656	0
Research Assistant/Field							0	0
Personnel (40%/10%) x 2	16,512	4,128	16,512	4,128	16,512	4,128	49,536	12,384
Support Staff (10%) x 1		2,048		2,048		2,048	0	6,144
Subtotal:	48,064	21,536	48,064	21,536	48,064	21,536	144,192	64,608
2. Travel - Regional/Local	7,000		7,000		7,000		21,000	0
3. Travel - Other		1,000		1,000		1,000	0	3,000
4. Supplies/expendable materials	7,500	6,000	7,500	6,000	7,500	6,000	22,500	18,000
5. Equipment (depreciable - list)								
a.							0	0
b.							0	0
c.							0	0
d.							0	0
Subtotal equip. costs:	0	0	0	0	0	0	0	0
6. Other miscellaneous (list)								
a. Publications							0	0
b.							0	0
c.							0	0
Subtotal Misc Costs:	0	0	0	0	0	0	0	0
7. Subtotal Direct Costs:	62,564	28,536	62,564	28,536	62,564	28,536	187,692	85,608
8. Overhead (14% - MERC)	8,759		8,759		8,759		26,277	
9. Total Direct & Indirect Co	71,323	28,536	71,323	28,536	71,323	28,536	213,969	85,608

ANNEX II

PROJECT TECHNICAL LEADERS RESUMES

VITA

Harry A. J. Hoitink,

Professor of Plant Pathology and Environmental Sciences Graduate Studies Program;
Leader, Solid Waste Technology Program

EDUCATION

Degree	Year	Institution	Major
Ing.	1957-60	Higher Agricultural College, Roermond, The Netherlands	General Science
B.Sc.	1963	MacDonald College - (Gold Scholar) St. Anne de Bellevue, Canada	Plant Pathology
M.Sc.	1964	McGill University, Montreal, Canada (NRC Scholar)	Plant Pathology
Ph.D.	1967	University of Wisconsin, Madison	Plant Pathology & Bacteriology

PROFESSIONAL EXPERIENCE

1995 - present — Program Leader, Solid Waste Technology Program, and Professor, Departments of Plant Pathology, The Ohio State University, Ohio Agricultural Research and Development Center and Environmental Sciences Graduate Studies Program, The Ohio State University, Columbus

1987 - 1995 — Professor, Departments of Plant Pathology, The Ohio State University, Ohio Agricultural Research and Development Center and Environmental Sciences Graduate Studies Program, The Ohio State University, Columbus

1977 - 1987 — Professor, Department of Plant Pathology, The Ohio State University, Ohio Agricultural Research and Development Center, Wooster

1971 - 1977 — Associate Professor, Department of Plant Pathology, The Ohio State University, Ohio Agricultural Research and Development Center, Wooster

1967 - 1971 — Assistant Professor, Department of Plant Pathology, The Ohio State University, Ohio Agricultural Research and Development Center, Wooster

1964 - 1967 — Research Assistant, Department of Plant Pathology, University of Wisconsin, Madison

1963 - 1964 — Research Fellow, McGill University, Montreal, Canada

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HONORS AND EDUCATIONAL RECOGNITION

ASAE Blue Ribbon Award for "On-Farm Composting Handbook"; awarded November 1993
Fellow of the American Phytopathological Society; Awarded August 1992
Visiting Professor, January 26-March 21, 1990, Biological and Chemical Research Institute, Rydalmere, NSW, Australia
US-EPA 1988 National Beneficial Sludge Use Award for "Outstanding Research on the Kinetics of Composting"; awarded October 3, 1988 at the 61st Annual Water Pollution Control Federation Conference, Dallas, TX
Fulbright Lecturer, August 22-September 2, 1983, Facultad De Biologia, Universidad De Barcelona, Barcelona, Spain
Canada National Research Council Scholar, 1963 and 1964
McGill University Gold Scholar, 1983 (highest ranking student at undergraduate level)
Rohm and Haas Prize in Plant Pathology, McGill University, 1963

PROFESSIONAL SOCIETY MEMBERSHIPS AND ACTIVITIES

American Association for Advancement of Science
American Phytopathological Society
American Phytopathological Society, Bacteriology Committee, 1968-1973; Chairman - 1972
American Phytopathological Society, Biological Control Committee, 1978-1983; Chairman - 1982
Ohio EPA task force for development of guidelines for utilization of papermill sludges and agricultural wastes
Associate Editor, Plant Disease, 1986, 1987, 1988
Editorial Board Member for Compost Science and Utilization, 1993, 1994, 1995
Associate Editor of Soil Ecology 1993, 1994, 1995

RESEARCH INTEREST

Dr. Harry A. J. Hoitink is the Program leader for the OSU Solid Waste Technology Program. Since 1972, he has concentrated on the development of optimum process parameters for composting of wastes and on mechanisms of biological control of diseases caused by soilborne plant pathogens in compost-amended substrates. His students have determined the fate of fungal and bacterial biocontrol agents in the composting and curing processes. His group has identified microorganisms, that when added to composts after peak heating, suppress or eradicate plant pathogens. Present research focuses on 1) organic matter transformations in composts that sustain the activity of biocontrol agents and 2) composting procedures that enhance activity of this microflora. He also was the principal organizer for an International Symposium on Composting Research (1992).

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THESES AND DISSERTATIONS

Doctoral Students

W. W. P. Gerlach. 1974. Biology of shoot blight, dieback, and crown rot of *Pieris japonica.* Ph.D. Thesis, The Ohio State Univ. 82 p.

Present Position: Professor and Chairman, Institut fur Botanik and Pflanzenschutz, 8050, Freising 12, West Germany

E. B. Nelson. 1982. Studies on the nature and mechanisms of suppression of *Rhizoctonia solani* in hardwood bark composts. Ph.D. Thesis, The Ohio State Univ. 93 p.

Present Position: Associate Professor, Department of Plant Pathology, Cornelll Univ., Ithaca, NY.

W. Chen. 1987. Nature and mechanisms of suppression of damping-off caused by Pythium *ultimum* in container media. Ph.D. Thesis, The Ohio State Univ. 149 p.

Present Position: Illinois Natural History Survey, University of Illinois, Urbana, IL

Awards: 1. W. E. Krauss Director's Award for Excellence in Research , OARDC, 1987

2. C. C. Allison Award for Excellence in Research in Plant Pathology, 1986

Y. R. Chung. 1988. Suppression of *Rhizoctonia solani* and its interaction with *Trichoderma hamatum* in bark compost container media. Ph.D. Thesis, The Ohio State Univ. 116 p.

Present Position: Associate Professor, Department of Microbiology, Seoul University, Seoul, Korea.

M. J. Boehm. 1992. Microbial ecology of Canadian sphagnum peat and compost-amended potting mixes varying in suppressiveness to Pythium root rot and damping-off. Ph D Thesis, The Ohio State University 75 p.

Present Position: Assistant Professor, Dept. of Biology, Monmouth College, Mommouth, Ill 61462.

Awards: C. C. Allison Award for Excellence in Plant Pathology, 1990.

M. E. Grebus. 1995. Development of Plant Disease Suppressive Compost-Amended Biocontrol Agent-Fortified Potting Mixes and Turf Topdressings and Use of Random

Amplified Polymorphic DNA Markers for Identification of *Trichoderma Hamatum* 382. Ph D Thesis, The Ohio State University.

Position after July 1995: Assistant Professor, Deptartment of Plant Pathology, University of California, Riverside, CA.

M. S. Students

D. G. Chef. 1977. Suppression of Fusarium wilt of chrysanthemum in composted hardwood bark. M.S. Thesis, The Ohio State Univ. 38 p.

L. M. Basham. 1980. Extraction and partial purification of non-volatile fungal inhibitors from composted hardwood bark. M.S. Thesis, The Ohio State Univ. 99 p.

E. B. Nelson. 1980. Factors affecting suppression of *Rhizoctonia solani* in composted hardwood bark container media. M.S. Thesis, The Ohio State Univ. 60 pp.

W. Chen. 1984. Suppression of cucumber damping-off and survival of the pathogen, *Pythium ultimum* Throw in contianer media amended with composted hardwood tree bark. M.S. Thesis, The Ohio State Univ. 46 p.

M. I. Trillas-Gay. 1985. The nature of suppression of radish Fusarium wilt in container media. M.S. Thesis, The Ohio State Univ. 88 p.
Award: Fulbright Scholarship

Present Position: Associate Professor, Department of Plant Physiology, University of Barcelona, Barcelona, Spain, as of Jan. 1995.

Petra Kip. 1988. The composting of poultry manure with special reference to nitrogen and bulking agents. M.S. Thesis, The Ohio State Univ. 71 p. Department of Agricultural Engineering and Department of Plant Pathology, OARDC/OSU. MS Agr. Univ., Wageningen, The Netherlands.

V. P. Atmatjidou. 1990. Transmission of *Xanthomonas campestris* pv. *begoniae*, the causal agent of bacterial leaf spot and blight of begonia (*Begonia hiemalis*), in the ebb and flow production system. M.S. Thesis, The Ohio State Univ. 53 pp.

M. J. Boehm. 1990. Suppression of Pythium root rot of poinsettia in Canadian sphagnum peat and compost-amended container media. M.S. Thesis, The Ohio State Univ. 73 pp.

M. E. Grebus. 1992 Biological, chemical and physical properties of composted yard waste as indicators of maturity and plant disease suppression. M.S. Thesis, The Ohio State Univ.

T. Wu. 1993. Impact of sphagnum peat decomposition level on efficacy of introduced and natural biocontrol agents in inducing suppression of Pythium root rot. M.S. Thesis, The

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Ohio State Univ. 82 pp.

Present Graduate Student Status:

A. Stone	Ph.D	Environmental Sciences
D. Han	Ph.D.	Plant Pathology/Biotechnology
W. Zhang	Ph.D.	Natural Resources/Plant Pathology
K. Blankenship	M.S	Plant Pathology

INVITED LECTURES AT UNIVERSITIES, INSTITUTES AND INTERNATIONAL MEETINGS

Department of Plant Pathology, Landbouw Hoge School, Wageningen, The Netherlands, June 1971. "Role of the bacterial cell wall in disease initiation."

Department of Plant Pathology, Oregon State University, Corvallis, OR, February 1973. "Phytophthora diseases of Ericaceae."

Department of Plant Pathology, University of Tennessee, Knoxville, TN, February 1975. "Biological control of Phytophthora root rot."

Instituut voor Onderzoek van Schimmelkulturen, Baarn, The Netherlands, July 1976. "Fungicidal properties of composted hardwood bark."

Department of Plant Pathology, Michigan State University, East Lansing, MI, January 1977. "Eradication of plant pathogens through composting."

Department of Soil Science, Kyoto University, Kyoto, JAPAN, May 1978. "Biological control of soil-borne plant pathogens."

Department of Horticulture and Plant Pathology, University of Georgia, Athens, GA, July 1978. "Disease control during plant propagation."

Department of Plant Pathology, Oregon State University, Corvallis, OR, February 1978. "Suppressive container media."

Institute Nationale Recherche Agriculture, Versailles, FRANCE, June 1979. "Biological control of *Phytophthora* spp."

Department of Plant Pathology, University of Minnesota, St. Paul, MN, October 1979. "Suppression of plant pathogens in soil-less container media."

Department of Microbiology and Pharmacognosy, The Ohio State University, Columbus, OH, February 1980. "Microbial antagonists and natural fungicides in suppression of soil-borne plant pathogens."

Lockwood Lecturer, Connecticut Agricultural Experiment Station, New Haven, CN, May 1980. "Mechanism of suppression of soilborne plant pathogens by composts."

US-EPA, Municipal Environmental Research Laboratory, Cincinnati, OH, January 1980. "Recycling of organic wastes."

Eastern Root Rot Conference, North Carolina State University, Raleigh, NC, May 1981. "Mechanism of suppression of plant pathogens in container media amended with compost."

University of Western Australia, Perth, S.W. Australia, August 1983. "Controlled recolonization of composts with antagonists of plant pathogens."

Department of Microbiology, Hebrew Univeristy of Jerusalem, Rehovot, Israel. October 1983. "Role of organic matter in suppression of *Phytophthora cinnamomi.*"

Int. Soc. Hort Science, August 1984. University Gent, Belgium. "Suppression of soilborne plant pathogens in compost-amended substrates."

Department of Microbiology, Hebrew University of Jerusalem, Rehovot, Israel. November 4-8, 1985. "Mechanisms of suppression of plant pathogens in soil-less substrates."

Faculty of Biology, University of Barcelona, Barcelona, Spain. November 11-12, 1985. "Recycling of organic wastes through composting. Formulation of container media with composts."

Departments of Plant Pathology and Agricultural Engineering, Clemson University, Clemson, S. C. March 10-11, 1986. "Mechanisms of suppression of soilborne plant pathogens in soil-less substrates."

University of Udine. Undine, Italy. April 16-19, 1986. "Effect of compost maturity on suppression of soilborne plant diseases."

Department of Agronomy, The Ohio State University, Columbus. February 11, 1987. "Composted organic wastes for the control of soilborne plant pathogens."

NSF Workshop on interactions between soil-inhabiting invertebrates and microorganisms in relation to plant growth, The Ohio State University, Columbus. March 23-27, 1987. "Interactions between organic matter transformation level and soilborne disease severity."

Department of Phyto Pathology, Landbouw University, Wageningen, The Netherlands. June 25, 1987. "Interactions between organic matter decomposition level and soilborne disease severity."

Department of Botany, Cleveland State University, Cleveland. April 10, 1987. "Synergistic interactions among biocontrol agents of *Rhizoctonia solani* in the rhizosphere."

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Department of Plant Pathology, Iowa State University, Ames. October 20, 1987. "Microbial activity and biomass as predictors of Pythium damping-off severity."

Department of Botany, Ohio University, Athens. November 6, 1987. "Mechanisms of suppression of plant pathogens by composts."

IAPAR, Londrina, PR, Brazil. February 11, 1988. "Recycling of organic wastes and biological control of soilborne plant pathogens."

National Research Council, Workshop to Determine Research Needs and Priorities of Plant-Microbe Interactions in Support of Biological Control of Plant Diseases, Washington, DC. July 17-19, 1988. "Mechanisms of biocontrol in composts."

International Symposium on Compost Production and Use, San Michele All'Adige, Trento, ITALY. June 19-23, 1989. "Control of compost production as related to product quality."

Biological and Chemical Research Institute, Ryadalmere, NSW, Australia. February 6, 1990. "General versus specific suppression of soilborne plant pathogens in compost-amended container media."

Australian Effluent Reuse Conference, Wollongong University, Wollongong, NSW, Australia. February 13-17, 1990. "Good and bad composting systems: Microbial process control or materials handling is excessive."

University of Western Australia, Nedlands, W.A. February 22, 1990. "Plant disease control through waste recycling."

Scientists' Institute for Public Information, Workshop on Environmental Reporting, The Case Western University, Cleveland, OH. March 28, 1990. "Alternate disposal methods, including recycling, composting and new technologies."

Bord na Mona Peat Research Centre Symposium, Newbridge, Ireland. May 23-25, 1990. "Interactions between organic matter and microorganisms in biological control of soilborne plant diseases."

Composting Seminar, Olds College, Olds, Alberta, Canada. September 25, 1990. "Principles of composting - guidelines of the process of microbiology."

Wageningen University, Wageningen, The Netherlands, December 4, 1990. GFT Composting Workshop. "De bestryding van plantenziekten door foepassing van compost."

American Society of Microbiology, Dallas, TX. May 8, 1991. "Suppression of plant pathogens with composts."

Discussion Session, APS Annual Meeting, St. Louis, MO. August 29, 1991. "Microbial activity assays and NMR spectroscopy as predictors of the general suppression phenomenon."

4th Brazilian meeting on Biological Control of Plant Diseases, Campinas, S.P. Brazil, October 8-10, 1991. "Interactions between organic matter decomposition level, biocontrol agents, and plant pathogens in soilborne disease."

ASA-CSSA-SSA Annual Meeting, Denver, CO, October 27-November 1, 1991. Symposium on composting of organic wastes. "Interactions between compost quality, plant growth response and disease."

International Compost Research Symposium, The Ohio State University, OARDC, Columbus, OH. May 27-29, 1992. "Mechanisms of suppression of soilborne plant pathogens with composts."

23rd Annual National Tropical Foliage Short Course, Ft. Lauderdale, FL. January 20-23, 1993. "Using pathogen suppressive potting mixes".

Department of Agronomy, Purdue University, Purdue, IL. Jan. 26, 1993. "Relationships between organic matter decomposition level, microbial species diversity and Pythium root rot suppression".

9th Conference on Insect and Disease Management of Ornamentals; Sponsored by The Society of American Florists, Del Mar, CA, February 20-22, 1993. "Suppressive soils for the control of root pathogens".

SWANA of Ohio, Annual Conference, Dayton, OH, April 13-14, 1993. "Choosing the right composting method: An overview of low and medium technology options".

Annual Biocycle Conference, St. Paul MN, May 11-13, 1993. Keynote Address: "Some key steps to successful composting".

USDA-ES. National Conference on Composting in Minneapolis, MN, June 2-4, 1993. "Biological control of soilborne plant pathogens with composts.

6th International Congress of Plant Pathology, Montreal, Canada, July 28 - Aug. 6, 1993. "The role of organic matter in the activity of biocontrol agents".

University of Minnesota, St. Paul, MN, August 11-12, 1993. "Sewage Sludge: Land Utilization and the Environment. "Beneficial effects induced by composted biosolids in horticultural crops".

American Phytopathological Society Annual Meeting, Nov. 8, 1993. "Dissemination and Transmission of plant pathogens in closed irrigation systems".

11th Annual Arborist Seminar and Trade Show, St. Charles, IL, December 6-7, 1993. "Compost, its Utilization, Benefits, Hazards and Pathogens".

Ohio State University Nursery Short Course, Columbus, OH, January 24, 1994. "Principles

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of Composting for Yard Wastes".

Ohio Turfgrass Short Course, Kings Island, OH, January 27, 1994. "Waste Recycling through Composting."

Farm Bureau, Lebanon, OH, January 27, 1994. "Ohio's Regulations Governing Recycling of Wastes through Composting".

Department of Plant Pathology, North Carolina State University, Raleigh, NC, February 28, 1994. "Biological Control of Soilborne Plant Pathogens with Composts".

Iowa State University Extension's 38th Annual Shade Tree Short Course, Ames Iowa. March 8-9, 1994. "Utilization of Composts in Nurseries and the Landscape".

38th Annual Shade Tree Chort Course, Iowa State University Extension's Ames Iowa. March 8-9, 1994. "Yardwaste Composting".

Plant Pathology Seminar, University of Wisconsin, Madison WI, March 10, 1994. "Sustained Biological Control of Plant Pathogens with Compost".

An International Symposium: `Nature and Uses for Spent Mushroom Substrate', College of Agricultural Sciences, the Pennsylvania State University, University Park, PA. March 11-14, 1994. "CPMAS ^{13}C-NMR Spectroscopy as a Predictive Tool for Compost Stability and Biological Control of Pythium Root Rot".

Western Soil Fungus Conference, John Ascuaga's Nugget, Reno, NV. March 29, 1994. "Dynamics of organic matter, pathogen and biocontrol agent interactions in soil-borne plant diseases".

British Society of Soil Science Annual Meeting, Silsoe Campus, Cranfield University, Cambridge, England. April 11-14, 1994. "CPMAS ^{13}C-NMR Spectroscopy as a predictive tool for compost stability and soil health.

British and Irish Chapter of the IHSS Spring Meeting, University of Birmingham, Birmingham, England. April 14-15, 1994. "Composting; An overview".

The Pennsylvania State University, College of Agriculture Symposium on the Environmen, College Park, PA. June 23, 1994. "The composting process for treatment of solid wastes".

Rocky Mountain Conference on spectroscopy, Denver CO. August 2, 1994. "Non-destructive CPMAS ^{13}C-NMR spectroscopy of soil organic matter for biocontrol of Pythium disease".

Department of Plant Pathology, Wageningen University, Wageningen, The Netherlands. September 26, 1994. "Mechanisms of biological control of soilborne plant diseases with composts."

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Department of soil and Water, Hebrew University of Jerusalem, Rehovot, Israel. Oct. 4, 1994. "Energy availability to beneficial soil microorganisms in relationship to biocontrol.

Ohio University, Department of Biology, Athens, OH. October 21, 1994. "Treatment of solid wastes through composting."

Department of Environmental Sciences, University of California, Berkeley, CA. November 7, 1994. "Composts as substitutes for methyl bromide in biological control."

Long Island Agricultural Forum, Cornell University, Riverhead N. Y. January 15 - 17, 1995. "Biological Control with composts".

PATENTS

Hoitink, H. A. J. Production of disease suppressive compost and micro- ogranisms for culture use therein. US Patent #4642131, February 10, 1987

Hoitink, H. A. J. Production of disease suppressive compost and container media, and microorganism culture for use therein. US Patent #4900348, February 13, 1990.

PUBLICATIONS

Refereed Articles

Hoitink, H. A. J., Pelletier, R. L., and Coulson, J. G. 1966. toxemia of halo blight of beans. Phytopathology 56:1062-1065.

Hoitink, H. A. J. 1967. survival, transmission, taxonomy and physiology of *Pseudomonas syringae* van Hall, the causal organisms of bacterial brown spot of bean (*Phaseolus vulgaris* L.). Can. J. Microbiol. 14:437-441.

Horst, R. K., and Hoitink, H. A. J. 1968. Occurrence of Cylindrocladium blights on nursery crops and control with fungicide 1991 on azalea. Plant Dis. Rep. 52:615-617.

Hoitink, H. A. J., and Schmitthenner, A. F. 1969. Phytophthora wilt of rhododendron caused by *Phytophthora citricola*. Phytopathology 59:708-709.

Hoitink, H. A. J., and Sinden, S. L. 1970. Partial purification and properties of chlorosis inducing toxins of *Pseudomonas phaseolicola* and *Pseudomonas glycinea*. Phytopathology 60:1236-1237.

Hoitink, H. A. J., and Schmitthenner, A. F. 1970. Disease control in rhododendron cuttings with benomyl or thiobendazole in hormone mixtures. Plant Dis. Rep. 54:427-430.

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Thielges, B. A., and Hoitink, H. A. J. 1972. Fungicides aid rooting of eastern white pine cuttings. Forest Science 18:54-55.

Hoitink, H. A. J., and Daft, G. C. 1972. Bacterial stem rot of poinsettia a new disease caused by *Erwinia carotovora* var. *chrysanthemi*. Plant Dis. Rep. 56:480-484.

Gerlach, W. W. P., Hoitink, H. A. J., and Ellett, C. W. 1974. Shoot blight and stem dieback of *Pieris japonica* by *Phytophthora citricola*, *P. citrophthora* and *Botryosphaeria dothidea*. Phytopathology 64:1368-1370.

Hoitink, H. A. J., and Schmitthenner, A. F. 1974. Relative prevalence and virulence of *Phytophthora* species involved in rhododendron root rot. Phytopathology 64:1371-1374.

Hoitink, H. A. J., and Schmitthenner, A. F. 1974. Resistance of rhododendron species and hybrids to Phytophthora root rot. Plant Dis. Rep. 58:650-653.

Hoitink, H. A. J., and Schmitthenner, A. F. 1975. Comparative efficacy of 2-chloro-6-methoxy-4 (trichloromethyl) pyridine and ethazole for control of Phytophthora root rot of rhododendron and soybean. Phytopathology 65:69-73.

Hoitink, H. A. J., Daft, G., and Gerlach, W. W. P. 1975. Phytophthora shoot blight and stem dieback of azalea and pieris and its control. Plant Dis. Rep. 59:235-237.

Gerlach, W. W. P., Hoitink, H. A. J., and Schmitthenner, A. F. 1976. Infection, sporulation and dissemination of *Phytophthora citrophthora* on *Pieris japonica*. Phytopathology 66:302-308.

Gerlach, W. W. P., Hoitink, H. A. J., and Schmitthenner, A. F. 1976. Survival and host range of *Phytophthora citrophthora* in Ohio nurseries. Phytopathology 66:309-311.

Hoitink, H. A. J., Herr, L. J., and Schmitthenner, A. F. 1976. Survival of plant pathogens during composting of hardwood bark. Phytopathology 66:1369-1372.

Hoitink, H. A. J., VanDoren, D. M. Jr., and Schmitthenner, A. F. 1977. Suppression of *Phytophthora cinnamomi* in hardwood bark compost. Phytopathology 67:561-565.

Daft, G. C., Poole, H. A., and Hoitink, H. A. J. 1978. Composted hardwood bark: A substitute for steam sterilization and fungicide drenches for control of Poinsettia crown and root rot. Hort Science 14:185-187.

Hoitink, H. A. J., and Poole, H. A. 1980. Factors affecting quality of composts for utilization in container media. Hort Science 15:171-173.

Hoitink, Harry A. J. 1980. Composted bark, a lightweight growth medium with fungicidal properties. Plant Disease 64:142-147.

Spring, D. E., Ellis, M. A., Spotts, R. A., Hoitink, H. A. J., and Schmitthenner, A. F. 1980. Suppression of the apple collar rot pathogen in composted hardwood bark. Phytopathology 70:1209-1212.

Stephens, C. T., Herr, L. J., Hoitink, H. A. J., and Schmitthenner, A. F. 1981. Suppression of Rhizoctonia damping-off by composted hardwood bark medium. Plant Disease 65:796-797.

Nelson, E. B., and Hoitink, H. A. J. 1982. Factors affecting suppression of *Rhizoctonia solani* in container media. Phytopathology 72:275-279.

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EDUCATION

Ph.D. in natural resource economics, University of Wisconsin, Madison, 1980

B.S. with honors in economics, University of Oregon, Eugene, 1974.

PROFESSIONAL EXPERIENCE

A faculty member in Ohio State University's Department of Agricultural Economics since 1980, Dr. Southgate was promoted to full professor in 1995. His responsibilities include undergraduate and graduate teaching as well as research. In 1994, Dr. Southgate was named director of the university's Latin American Studies Program.

Dr. Southgate consults seven to ten weeks a year. A description of recent consulting assignments follows.

> *May through July 1995, Tratado de Cooperación Amazónica and Economic Development Institute of the World Bank.* Prepared guidelines for the economic evaluation of sustainable production systems proposed for the Amazon Basin.
>
> *March and April 1995, Ecuador U.S. Agency for International Development.* Directed team of consultants who carried out urban and industrial environmental assessment.

March 1995, International Institute for Environment and Development. Evaluated program of environmental economics research in Brazil, Costa Rica, Ivory Coast, and Thailand.

June and July 1994, Ecuador, U.S. Agency for International Development. Contributed to the design of a project to foster sustainable use of timber and other biological resources and prepared an economic analysis of that same project.

May 1994, Venezuela, World Bank. Lectured on environmental economics for Economics Development Institute short course.

December 1993 and March 1994, Ecuador, World Bank. Drafted environmental summary for proposed project to improve agricultural research and extension.

August and September 1993, Ecuador, Inter-American Development Bank. Contributed to the preparation of an agricultural sector loan by identifying critical needs for natural resource policy reform and related technical assistance.

SELECTED PUBLICATIONS

Southgate, D. and M. Whitaker, *Economic Progress and the Environment: One Country's Policy Crisis.* New York: Oxford University Press, 1994.

Southgate, D., "Tropical Deforestation and Agricultural Development in Latin America," in K. Brown and D. Pearce (eds.), *The Causes of Tropical Deforestation: The Economic and Statistical Analysis of Factors Giving Rise to the Loss of Tropical Forests.* London: University College London Press, 1994. Vancouver: University of British Columbia Press, 1994.

Southgate, D. and H. Clark, "Can Conservation Projects Save Biodiversity in South America," *Ambio* 22:2-3 (1993) 163-166.

Brazee, R. and D. Southgate, "Development of Ethnobiologically Diverse Tropical Forests," *Land Economics* 68:4 (1992) 454-461.

Southgate, D. and M. Basterrechea, "Population Growth, Public Policy and Resource Degradation: The Case of Guatemala," *Ambio* 21:7 (1992) 460-464.

Southgate, D. and M. Whitaker, "Promoting Resource Degradation in Latin America: Tropical Deforestation, Soil Erosion, and Coastal Ecosystem Disturbance in Ecuador," *Economic Development and Cultural Change* 40:4 (1992) 787-807.

Southgate, D., R. Sierra, and L. Brown, "The Causes of Tropical Deforestation in Ecuador," *World Development* 19:9 (1991) 1145-1151.

Southgate, D., J. Sanders, and S. Ehui, "Resource Degradation in Africa and Latin America: Population Pressure, Policies, and

Property Arrangements," *American Journal of Agricultural Economics* 71:5 (1990) 1259-1263.

Southgate, D., "The Causes of Land Degradation along 'Spontaneously' Expanding Agricultural Frontiers in the Third World," *Land Economics* 66:1 (1990) 93-101.

- curriculum vitae -

DOUGLAS D. SOUTHGATE, JR.

Address and Telephone and FAX Numbers

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TEL -- (614) 292-2432 FAX -- (614) 292-4749

Personal Data

Born: [redacted]
Citizenship: United States
Soc. Sec. No.: [redacted]
Family Status: Married, two children

Education

B.S. (Honors), University of Oregon, June 1974. Major in Economics.

Ph.D., University of Wisconsin - Madison, Department of Agricultural Economics, December 1980. Major in Natural Resource Economics.

Current Employment

Since September 1980, faculty member in Ohio State University Department of Agricultural Economics. Promoted to Associate Professor with tenure in July 1986. Director of University Latin American Studies Program since July 1994.

Special Assignments and Previous Employment

August 1990 through July 1993, Joint Career Corps assignment with U.S. Agency for International Development in Quito, Ecuador.

January through July 1987, Fulbright Research Fellow in Quito, Ecuador.

September 1975 through August 1980, Graduate Research and Teaching Assistant in University of Wisconsin Departments of Economics and Agricultural Economics.

Since 1985, short-term consultancies in nine Latin American and Caribbean countries for the U.S. Agency for International Development, the Inter-American Bank, the World Bank, and the Ford Foundation.

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Teaching Experience

Courses taught at Ohio State University: Introduction to Economics, Undergraduate Natural Resource Economics, Undergraduate Research Methods, Undergraduate Course on Food and the Environment, Graduate Linear Programming, Graduate Operations Research, and Graduate Natural Resource Economics.

Fourteen short courses on environmental and natural resource economics and linear programming taught in Brazil, the Dominican Republic, and Ecuador since 1986.

Publications

- Books

Southgate, D. and M. Whitaker, Economic Progress and the Environment: One Developing Country's Policy Crisis. New York: Oxford University Press, 1994.

Southgate, D. and J. Disinger (eds.), Sustainable Development of Natural Resources in the Third World. Boulder: Westview Press, 1987.

- Book Chapters

Southgate, D., "Economic Progress and Habitat Conservation in Latin America," in T. Swanson (ed.), The Economics and Ecology of Biodiversity Decline. Cambridge: Cambridge University Press, 1995.

Southgate, D., "Tropical Deforestation and Agricultural Development in Latin America," in K. Brown and D. Pearce (eds.), The Causes of Tropical Deforestation: The Economic and Statistical Analysis of Factors Giving Rise to the Loss of Tropical Forests. London: University College London Press, 1994. Vancouver: University of British Columbia Press, 1994.

Southgate, D., "The Rationality of Land Degradation in Latin America: Some Lessons from the Ecuadorian Andes," in T. Napier, S. Camboni, and S. El-Swaify (eds.), The Socioeconomics of Soil and Water Conservation: An International Perspective. Ankeny: Soil and Water Conservation Society Press, 1994.

Southgate, D., "Policies Contributing to Agricultural Colonization of Latin America's Tropical Forests," in N. Sharma (ed.), Managing the World's Tropical Forests: Looking for Balance between Conservation and Development. Dubuque: Kendall/Hunt Publishing Company, 1992.

Southgate, D., D. Pearce, and R. Samanez, "Amazonian Deforestation: An Economic Perspective," in Informe Final del Seminario sobre Políticas y Prácticas para Desarrollo Sostenible en los Paises Miembros del Tratado de Cooperación Amazónica. Quito: Secretaría *Pro Tempore* del Tratado de Cooperación Amazónica, 1992.

Forster, D. and D. Southgate, "Economic Perspectives on Erosion and Nonpoint Source Pollution," in R. Lal (ed.), Soil Tillage and Agricultural Sustainability. International Soil Tillage Research Organization, 1991.

85

Southgate, D., "Influencia de las Políticas en el Uso y la Gestión de los Recursos Naturales Renovables de América Latina," in J. Vial (ed.), Desarrollo y Medio Ambiente: Hacia un Enfoque Integrador. Santiago: Corporación de Investigaciones Económicas para Latinoamérica, 1991.

Southgate, D., "Development of Ecuador's Renewable Natural Resources," in M. Whitaker and D. Colyer (eds.), Agriculture and Economic Survival: The Role of Agriculture in Ecuador's Economic Development. Boulder: Westview Press, 1990.

Southgate, D., "Three Current Land Use Issues in the United States," in D. Pearce and F. Juhasz (eds.), Renewable Natural Resources: Economic Incentives for Improved Management. Paris: Organization for Economic Cooperation and Development, 1990.

Southgate, D. and F. Hitzhusen, "Economic Analysis of Renewable Resource Conservation in the Third World," in D. Southgate and J. Disinger (eds.), Sustainable Development of Natural Resources in the Third World. Boulder: Westview Press, 1987.

Southgate, D. and A. Veloz, "The Economics of Watershed Management: Two Case Studies from Latin America," in I. Sentis (ed.), Soil Conservation and Productivity. Maracay: Universidad Central de Venezuela, 1987.

Hitzhusen, F., R. Macgregor, D. Southgate, and A. Veloz, "Hydropower Impacts of Soil Erosion: Private and Social Cost-Benefit Perspectives," in F. Hitzhusen and R. Macgregor (eds.), A Multi-Disciplinary Approach to Renewable Energy in Developing Countries. Columbus: Publishing Horizons, Inc., 1986.

Forster, D., T. Logan, G. Pierzynski, and D. Southgate, "Institutional Constraints on Residuals Use," in Brown *et al.* (eds.), Utilization, Treatment, and Disposal of Waste on Land. Madison: Soil Science Society of America, 1986.

Forster, D. and D. Southgate, "Institutional Constraints," in Page *et al.* (eds.), Proceedings of 1983 Workshop on the Utilization of Municipal Wastewater and Sludge on Land. Riverside: University of California Press, 1983.

Southgate, D., H. Hoitink, T. Logan, W. Faber, and E. Smith, "Developing a Compost Marketing Strategy for Akron, Ohio," in E. Stentiford (ed.), Proceedings of the International Conference on Composting of Solid Wastes and Slurries. Leeds: University of Leeds, Department of Civil Engineering, 1983.

- Journal Articles

Southgate, D. and H. Clark, "Can Conservation Projects Save Biodiversity in South America?" Ambio, 22:2-3 (1993) 163-166.

Brazee, R. and D. Southgate, "Development of Ethno-Biologically Diverse Tropical Forests," Land Economics 68:4 (1992) 454-461.

Southgate, D. and M. Basterrechea, "Population Growth, Public Policy, and Resource Degradation: The Case of Guatemala," Ambio 21:7 (1992) 460-464.

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Southgate, D. and M. Whitaker, "Promoting Resource Degradation in Latin America: Tropical Deforestation, Soil Erosion, and Coastal Ecosystem Disturbance in Ecuador," Economic Development and Cultural Change 40:4 (1992) 787-807.

Brown, L., R. Sierra, and D. Southgate, "Frontier Settlement in the Ecuadorian Amazon: Ground Level Reality versus General Frameworks, Environment and Planning 24 (1992) 939-961.

Southgate, D., "Petroleum Development in Tropical Rainforests: The Economics of Pollution Control in Eastern Ecuador," Ecodecisión 5 (1992) 78-81.

Southgate, D., R. Sierra, and L. Brown, "A Statistical Analysis of the Causes of Deforestation in Eastern Ecuador," World Development 19:9 (1991) 1145-1151.

Southgate, D., J. Sanders, and S. Ehui, "Resource Degradation in Africa and Latin America: Population Pressure, Policies, and Property Arrangements," American Journal of Agricultural Economics 71:5 (1990) 1259-1263.

Southgate, D., "The Causes of Land Degradation along 'Spontaneously' Expanding Agricultural Frontiers in the Third World," Land Economics 66:1 (1990) 93-101.

Southgate, D. and R. Macke, "The Downstream Benefits of Soil Conservation in Third World Hydroelectric Watersheds," Land Economics 65:1 (1989) 38-48.

Forster, D., C. Bardos and D. Southgate, "Soil Erosion and Water Treatment Costs," Journal of Soil and Water Conservation 42:5 (1987) 349-352.

Southgate, D., R. Taylor, and S. Uchida, "How Will the Greenhouse Industry Utilize Waste Heat?" Agribusiness: An International Journal 2:1 (1986) 65-75.

Southgate, D., S. Ott, N. Rask, and F. Walker, "The Agricultural Impacts of Increased Alcohol Industry Demand for Corn: The Case of Ohio," Energy in Agriculture 5 (1986) 211-223.

Southgate, D., S. Uchida, and E. Gadomski, "The Relationship between the Price of Waste Heat and Greenhouse Industry Production Systems," HortScience 20:6 (1985) 1121-1122.

Veloz, A., D. Southgate, F. Hitzhusen, and R. Macgregor, "The Economics of Erosion Control in a Subtropical Watershed: A Dominican Case," Land Economics 61:2 (1985) 145-155.

Southgate, D. and C. Runge, "Toward an Economic Model of Deforestation and Social Change in Amazonia," The Science of the Total Environment 55 (1986) 121-126 and Ricerche Economiche 39:4 (1985) 561-567.

Southgate, D., F. Hitzhusen, and R. Macgregor, "Dealing With Third World Soil Erosion Problems," American Journal of Agricultural Economics 65:5 (1984) 879-884.

Southgate, D., "Potential Markets for Akron Sludge-Derived Compost," Biocycle-Journal of Waste Recycling, 25:6 (1984) 42-43.

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Forster, D. and D. Southgate, "Social Institutions Influencing Land Application of Wastewater and Sludge," Journal of the Water Pollution Control Federation 56:5 (1984) 399-404.

Hitzhusen, F., R. Macgregor, and D. Southgate, "Private and Social Cost-Benefit Perspectives and a Case Application on Reservoir Sedimentation Management," Water International 9:4 (1984) 181-184.

Southgate, D. and D. Forster, "Institutional Constraints on Land Application," BioCycle-Journal of Waste Recycling 24:6 (1983) 37-38.

Southgate, D., N. Rask, T. Ryan, and S. Ott, "Projecting Food-Fuel Conflicts Resulting from Biomass Energy Development in Ohio," Energy in Agriculture 2 (1983) 307-317.

Southgate, D., B. Sharp, S. Lovejoy, and N. Bouwes, "A Case Study of Incentives for Adoption of Less-Polluting Manure Handling Techniques," North Central Journal of Agricultural Economics 2 (1980) 125-130.

Grants and Research Funding

"Defining the Emerging Market in Ohio for Wood Products Industry Residues Used To Generate Electricity" (principal investigator), Ohio Biomass Energy Program, Public Utilities Commission of Ohio, Columbus, October 1994 through July 1995. $20,000.

"Cooperative Agreement with Instituto de Estrategias Agropecuarias for Environmental Policy Analysis and Dialogue" (principal investigator), U.S. Agency for International Development, Quito, August 1992 through July 1993, $286,000.

Numerous contracts awarded to the Instituto de Estrategias Agropecuarias for research and policy analysis from three U.S. Agency for International Development projects [Agriculture and Rural Development Technical Services (LACTECH), Development Strategies for Fragile Lands (DESFIL), and Environmental Policy Analysis and Training (EPAT)], the Inter-American Development Bank, the World Bank, the U.N. Food and Agriculture Organization, and the World Wildlife Fund. Approximately $75,000 from January 1991 to June 1993.

"Joint Career Corps Assignment: Natural Resource Economics in Ecuador" (principal investigator), U.S. Agency for International Development, August 1990 through July 1993, $400,000.

"Management of the Big Darby Creek Watershed: Benefit-Cost Analysis" (principal investigator), The Nature Conservancy Ohio Field Office and Ohio State University Center for Mapping, April 1989 through June 1990, $20,000.

"Settlement of the Amazon Basin: An Ecuadorian Case Study" (principal investigator), Ohio State University Graduate School, May 1988 through May 1989, $4,000.

"Tropical Forest Management: A Graduate Fellowship Program" (co-principal investigator), Jesse Smith Noyes Foundation, September 1986 through August 1989, $35,000.

"Ohio State University Tropical Renewable Resources Program Title XII Strengthening Grant" (co-investigator), U.S. Agency for International Development, September 1985 through August 1987, $40,000.

"Economic Feasibility of Candidate Industries for the Piketon, Ohio Agribusiness Park" (co-principal investigator), Pike County Development and Energy Management Corporation, July 1984 through October 1984, $60,000.

"Alternative Manure Systems for Large Swine Facilities" (co-investigator), Ohio Environmental Protection Agency, October 1983 through February 1984, $45,000.

"Economic Analysis of Trade Offs between Soil Conservation and Crop Production Goals" (principal investigator), Ohio State University College of Agriculture, September 1983 through August 1984, $7,500.

"Ohio State University Department of Agricultural Economics Title XII Strengthening Grant" (co-investigator), U.S. Agency for International Development, September 1983 through August 1984, $17,000.

"Technical Assistance for Natural Resource Management in the Dominican Republic" (co-investigator and occasional Ohio State University campus coordinator), U.S. Agency for International Development, November 1982 through July 1986, $215,000.

"An Integrated Regional Analysis of Potential Biomass Energy Production in Ohio" (co-investigator), Ohio Department of Energy, September 1981 through February 1983, $60,000.

"Akron Sludge Compost Market Development" (principal investigator), U.S. Environmental Protection Agency and City of Akron, Ohio, November 1981 through August 1983, $160,000.

"Economic Value of Ohio's Lake Erie Fisheries" (co-principal investigator), Ohio Sea Grant College Program, September 1980 through August 1982, $50,000.

Honors, Awards, and Professional Organizations

Inducted into Gamma Sigma Delta (agricultural honorary), 1994
Named Honorary Fellow, Instituto de Estrategias Agropecuarias, 1993
Inducted into Phi Beta Delta (international scholars' honorary), 1990
Tropical Ecosystems Directorate, U.S. Man and the Biosphere Program, 1989-90
Founding Associate Fellow, London Environmental Economics Centre (University College London and International Institute for Environment and Development), 1988
Award To Travel to Twentieth International Conference of Agricultural Economists, American Agricultural Economics Association, 1988
Fulbright Research Fellowship, Ecuador, 1987
National Security Award, Ohio State University Mershon Center, 1985

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Inducted into Phi Beta Kappa, University of Oregon, 1974
Honors at Graduation, University of Oregon, 1974
Member of American Economic Association, American Agricultural Economics Association, Association of Environmental and Resource Economists, International Association of Agricultural Economists, and Fulbright Alumni Association

Foreign Language Proficiency

Spanish (reading, writing, speaking)
Portuguese (reading, speaking)
French (reading)

November 1994

YONA CHEN, Curriculum Vitae

1. **Personal**:

[redacted]; Military Service (1959-1962); Married (1964); Two children (1966, 1969).

2. **Main Research Interests**:

The physical chemistry of humic substances, minerals and their interactions. Effects of organic matter on soil fertility and structure. The role of organic matter and bacteria in the iron nutrition of plants. Recycling of agricultural wastes and the application of composts as soil conditioners and as peat substitutes in horticulture. Chemical transformations in decomposing organic matter.

3. **Education**:

B.Sc. in Soil Science (with honors, 1967); M.Sc. in Soil Science (with honors, 1970); Ph.D. in Soil Physical Chemistry (1975). The three degrees were granted by the Hebrew University of Jerusalem.

4. **Professional Employment**:

4.1. At the Faculty of Agriculture, the Hebrew University of Jerusalem:
Assistant, Soil Chemistry (1970); Instructor, Soil Chemistry (1974); Lecturer of Soil Chemistry (1977); Senior Lecturer of Soil Chemistry (1979); Associate Professor of Soil Chemistry (1983); Full Professor of Soil Chemistry (1987-to date); Head, Department of Soil and Water Sciences and of the Seagram Center for Soil and Water Sciences (1986-1989); Dean, Faculty of Agriculture (1993-to date).

4.2. At Universities and Research Institutes Overseas:
Research Fellow, Chemistry and Biology Research Institute, Agriculture Canada, Ottawa, Canada (1975-1977); Visiting Professor, Department of Agronomy, University of Illinois, Urbana, Illinois (1981-1982); Visiting Professor, Department of Agronomy, University of Maryland and USDA-ARS, Beltsville, Maryland (1989-½ year); Visiting Professor, Institute of Environmental Sciences, The Pennsylvania State University, University Park, Pennsylvania (1990-½ year).

5. **Awards and Prizes**:

G. Cohen Award, the Hebrew University of Jerusalem, Rehovot, Israel (1968); Israel Society of Soil Science Mokady Award (1970); The G.A. Miller Distinguished Scientist Award, University of Illinois (1981); Fellow, American Society of Agronomy (1990); Fellow, American Society of Soil Science (1991).

6. **Editorial Activities with International Journals:**

Advisory Editorial Board of "Agricotura Mediterranea" (International Journal of Agricultural Science, CNR, Rome, 1987-to date); Consulting Editor "Plant and Soil" (Kluwer Press, The Netherlands, 1988-to date); Editorial Board "Critical Reviews in Environmental Science and Technology" (CRC Press, U.S.A., 1992-to date).

7. Other Professional Activities (selected):

7.1. Faculty of Agriculture, the Hebrew University of Jerusalem:
Chairman of Teaching Program in Soil and Water Sciences (1979-1981); Chairman, Sports and Recreation Committee (1983-1986); Member, Teaching Committee (1978-1981; 1986-1989); Member, Research Committee (1986-1989); Member, the Committee for Academic Development (1985-1986); Chairman, Department of Soil and Water Sciences (1986-1989); Chairman, the Seagram Fund for Research, Development and Training in Soil and Water (1986-1989); Chairman, Planning Committee for the Employment of Graduate Students (1986).

7.2. The Hebrew University of Jerusalem:
Chairman, Disciplinary Committee for Graduate Research Students (Ph.D. program) in Earth Sciences (1987-1989); Member, Committee of Long-Term Planning of Studies in Environmental Sciences (1990-1991); Chairman, Disciplinary Committee for Graduate Research Students (Ph.D. program) in Earth Sciences (1992-to date); Member, Committee for Promotions of Professors in Earth Sciences, Mathematics, Physics, Computer Sciences and Pharmacology (1991-to date).

7.3. International Professional Societies and Organizations:
Member, Organizing Committee of the Third International Symposium on Peat and Soil Organic Matter (1982-1983); Member, Organizing Committee of the Second International Symposium on Biosalinity (1983-1984); Member, Board of Directors, the International Association for Micronutrients in Agriculture - based in France (1984-1989); Member, Steering Committee, International Working Group on Iron Nutrition and Interactions in Plants (1985-to date); Representative of the Israel Ministry of Science and Development at the Fourth International Symposium on Processing and Use of Organic Sludge, E.E.C., Rome, Italy (1985); Member of Organizing Committee of the Second International Symposium on Behavior of Pollutants in Porous Media (1986-1987); Member of committee on Methods of Analysis, International Symposium on Horticultural Substrates and their Analysis, International Society of Horticultural Science, Denmark (1987); Member of delegation and scientific advisor, Committee for Cooperation between Israel and Germany on Research on Ecology - Israel Ministry for Science and Development (1986-1990); Chairman of the Organizing Committee of the Fifth International Symposium on Iron Nutrition and Interactions in Plants (1987-1989); Chairman, International Working Group of Iron Nutrition and Interactions in Plants (1989-1992); Member, Organizing Committee of the Sixth International Symposium on Humic Substances (Italy, 1992); Member of the Technical Advisory Committee (TAC), the U.S.-Israel Binational Research and Development Fund (1990-to date); Chairman of BARD-TAC Subcommittee for Postdoctoral Fellowships (1992).

7.4. National Professional Societies, Organizations and Governmental Committees: Member ofthe Board and Treasurer, The Israel Society of Soil Science (1978-1980); Member of the Board, Israel Fertilizer Research Center (1982-1989); Member of the Panel of Reviewers in Soil Science, The Israel Ministry of Agriculture (1983-1986); Member, Committee for Water Quality Control, Water Authority of Israel, The Israel Ministry of Agriculture (1988-1989); Member, Steering Committee for Research and Development on Sustainable Agriculture, The Israel Ministry of Agriculture (1984-1989; 1992-to date); Member, GIARA Steering Committee (Joint Germany-Israel Research Fund oriented towards developing countries, 1989-to date); Member, Steering Committee for Research and Development on Water Management, Irrigation and Recycling, The Israel Ministry of Agriculture (1991-to date); Member, Steering Committee for Research and Development on Energy in Agriculture, The Israel Ministry of Agriculture and the Israel Ministry of Energy (1991-to date); Member, Advisory Committee for Research and Development on Agriculture and the Environment, The Israel Ministry for Environmental Quality (1992-to date).

8. Publications No. (for details see attached list).

Dissertations (M.Sc.; Ph.D.) - 2
Books (co-edited) - 5
Invited reviews - 15
Chapters in books and proceedings - 14
Articles in reviewed journals - 103
Journals in Hebrew and other special publications - 36
Teaching manuals - 9

9. Teaching the Following Courses:

1. Introduction to Soil Science (undergraduate level)
2. Methods of Soil Analysis (undergraduate level)
3. Soil and Water Pollution (undergraduate level)
4. Recycling of Waste Products (undergraduate level)
5. Soil Organic Matter (graduate level).

10. Graduate Students Supervision and Co-supervision Activities:

1. M.Sc. candidates - completed dissertations, 23 students.
2. M.Sc. candidates - dissertations in preparation, 8 students.
3. Ph.D. candidates - completed dissertations, 6 students.
4. Ph.D. candidates - dissertations in preparation, 5 students.

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11. **Funded Research (selected; last 10 years):**

BARD. Anion adsorption to soil organic matter and peat.
EEC. Plant growth media produced by aerobic and anaerobic fermentation of agricultural wastes.
BARD. The use of agricultural wastes for preparation of disease suppressive composts.
BARD. Development of microbial siderophores as iron carriers for higher plants: Production, mode of action, and effectiveness.The Israel Ministry of Agriculture. Uptake mechanism of Fe in mango and new methods of fertilization.
Baden-Wurtenberg Fund. Microbial activity in the rhizosphere in relation to micronutrient nutrition.
The Israel National Coal Company. Recycling of bottom coal ash from power plants in agriculture.
The Kay Foundation. The role of raphorin - a new siderophore produced by Rhizopus arrhizus.
Baden-Wurtenberg Fund. Effects of microorganisms on the iron nutrition of plants.
The Israel Ministry of Agriculture. Solute and water transport in organic and inorganic container media.
BARD. Microbial activity in the rhizosphere in relation to the Fe nutrition of plants.
US-AID. Composting of municipal solid wastes - maturity indexes and potential problems and utilization.

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YONA CHEN

LIST OF PUBLICATIONS
(Updated November, 1994)

Dissertations

1. M.Sc. Chen, Y. 1970. The structure, solubility products and optical properties of clay minerals in suspension. M.Sc. thesis. The Hebrew University of Jerusalem.

2. Ph.D. Chen, Y. 1975. Evaluation of montmorillonite behavior and particle structure as a model for swelling and flow impediment in soils. Ph.D. thesis. The Hebrew University of Jerusalem.

Books

1. Chen, Y., and Y. Avnimelech (ed.) 1986. The Role of Organic Matter in Modern Agriculture. 306 pp. Martinus Nijhof-Kluwer, Dordrecht, The Netherlands.

2. Gerstl, Z., Chen, Y., Mingelgrin, U., and B.Yaron (ed.) 1989. Toxic Organic Chemicals in Porous Media. 250 pp. Springer-Verlag, Berlin, F.R.G.

3. Chen, Y., and Y. Hadar (ed.) 1991. Selected papers from the Fifth International Symposium on Iron Nutrition and Interactions in Plants. Plant and Soil 130:1-288.

4. Chen, Y., and Y. Hadar (ed.) 1991. Iron Nutrition and Interactions in Plants. 377 pp. Kluwer Academic Publishers, London, Great Britain.

5. Lahav, N., M. Shenker, and Y. Chen. 1994. Introduction to Soil Science. The Hebrew University of Jerusalem (in Hebrew; in press).

Invited Reviews (reviewed)

1. Chen, Y., Y. Hadar, and Y. Inbar. 1985. The use of composted agricultural waste as peat substitute in horticulture. pp. 388-392. In: P. L'Hermite (ed.). Processing and Use of Organic Sludge and Liquid Agricultural Wastes. Reidel Publishing Company, Boston.

2. Chen, Y., and Y. Hadar. 1986. Composting and use of agricultural wastes in container media. pp. 71-77. In: M. De Bertoldi, M.P. Feranti, P. L'Hermite, and F. Zucconi (ed.) Compost: Production, Quality and Use. Elsevier, New York.

3. Raviv, N., Y. Chen, and Y. Inbar. 1986. Peat and peat substitutes as growth media for container-grown plants. pp. 257-287. In: Y. Chen, and Y. Avnimelech (ed.) The Role of Organic Matter in Modern Agriculture. Martinus Nijhof, Dordrecht, The Netherlands.

4. Hadar, Y., E. Jurkevitch, and Y. Chen. 1986. The effect of Pseudomonas on iron nutrition of plants. pp. 43-48. In: R. Swinburne, (ed.) Iron, Siderophores, and Plant Disease. Plenum Press, New York.

5. Chen, Y., and F.J. Stevenson. 1986. Soil organic matter interactions with trace elements. pp. 73-116. In: Y. Chen, and Y. Avnimelech (ed.) The Role of Organic Matter in Modern Agriculture. Martinus Nijhof, Dordrecht, The Netherlands.

6. Bar, A., A. Banin, and Y. Chen. 1987. Adsorption and exchange of potassium in multi-ionic soil systems as affected by mineralogy. pp. 143-158. In: N. Celio and O. Steineck (ed.). Methodology in Soil-K Research. International Potash Institute, Berne, Switzerland.

7. Senesi, N., and Y. Chen. 1989. Interactions of toxic chemicals with humic substances. pp. 37-90. In: Z. Gerstl, Y. Chen, U. Mingelgrin, and B. Yaron (ed.). Toxic Organic Chemicals in Porous Media. Springer-Verlag, Berlin, F.R.G.

8. Chen, Y., and M. Schnitzer. 1989. Sizes and shapes of humic substances by electron microscopy. pp. 622-638. In: M.H.B. Hayes, P. MacCarthy, R.L. Malcolm and R.S. Swift (ed.). Humic Substances II: In Search of Structure. John Wiley, N.Y.

9. Chen, Y., and T. Aviad. 1990. Effects of humic substances on plant growth. pp. 161-186. In: P. MacCarthy, C.E. Clapp, R.L. Malcolm, and P.R. Bloom (ed.) Humic Substances in Soil and Crop Sciences: Selected readings. Am. Soc. Agron., Soil Sci. Soc. Am., Madison, Wisconsin.

10. Chen, Y., A. Gamliel, J.J. Stapelton, and T. Aviad. 1991. Chemical, physical and microbial changes related to plant growth in disinfested soils. pp. 103-129. In: J. Katan and J.E. DeVay (ed.). Soil Solarizatio. CRC Press, Boston, U.S.A.

11. Inbar, Y., Y. Chen, and Y. Hadar. 1991. Approaches to determining compost maturity. pp. 183-187. In: J. Goldstein (ed.) The Art and Science of Composting. JG Press, Emmanus, Pennsylvania.

12. Chen, Y., and Y. Inbar. 1993. Chemical and spectroscopic analyses of organic matter transformations during composting in relation to compost maturity. pp. 551-600. In: H.A.J. Hoitink and H.M. Keener (eds.) Science and Engineering of Composting: Design, Environmental, Microbiology and Utilization Aspects. Renaissance Publications, Worthington, OH, U.S.A.

13. Inbar, Y., Y. Chen, and H.A.J. Hoitink. 1993. Properties for establishing standards for utilization of composts in container media. pp. 668-694. In: H.A.J. Hoitink and H.M. Keener (eds.) Science and Engineering of Composting: Design, Environmental, Microbiology and Utilization Aspects. Renaissance Publications, Worthington, OH, U.S.A.

14. Chen, Y. 1993. Humic substances originating from rapidly decomposing organic matter: Properties and affects on plant growth. In : Senesi, N. Humic Substances in the Environment and in Agriculture. Sci. Total Environ. (in press).

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22. Bazak, H., O. Surin, Y. Chen. 1990. The response of grape-vines in the Lachish area to Fe-enriched manure. Alon-Hanotea 44:301-306.

23. Shenker, M., Y. Chen, and S. Gazit. 1990. Iron deficiency in mango trees - new approaches to fertilization and iron uptake mechanisms. Alon-Hanotea 11:1027-1032.

24. Dayan, R, R. Ophenbach, Y. Tsvieli, A. Maduel, Y. Chen, A. Gotesman, Y. Inbar, S. Kremer, and O. Oku. 1990. Greenhouse tomato production in the Dead Sea region, Israel. Hassadeh 70:1218-1222.

25. Gerstel, Z., D. Dornai, Y. Chen, and U. Mingelgrin. 1990. Effects of trifluralin on vegetative and reproductive growth of cotton in the Northern Negev, Israel. Hassadeh 71:792-795.

26. Chen, Y., A. Gotesman, Y. Inbar, A. Grinberger, Y. Neubauer, S. Gilboa, and U. Adler. 1991. Production of melons in container media in the Jordan Valley, Israel. Hassadeh 71:1172-1175.

27. Chen, Y., Y. Inbar, T. Aviad, R. Dayan, D. Michaeli, B. Waknin, R. Ophenbach, Y. Katan, A. Gamliel, and E. Hadar. 1991. Recycling and disinfestation of container media for melon production in the Arava. Hassadeh 71:1495-1501.

28. Gerstel, Z., D. Dornai, Y. Chen, and U. Mingelgrin. 1991. The behavior of the herbicides trifluralin and dinitramine in soils of the Northern Negev, Israel. Hassadeh 71:792-795.

29. Harpaz, M., Y. Chen, and S. Gazit. 1991. Evaluation of various methods of iron nutrition of mango trees grown on a loamy-clay highly-calcareous soil. Alon-Hanotea 45:701-707.

30. Chen, Y., and Y. Inbar. 1991. The present and future use of container media in Israel. Phytoparasitica 19:161-162.

31. Chen, Y., Y. Inbar, T. Aviad, Y. Katan, A. Gamliel, E. Hadar, Y. Tsvieli, R. Dayan, R. Ofenbach, B. Vaaknin, and M. Arnon. 1992. Reuse of container media for spring melon growth in greenhouses. Hassadeh 72:556-559.

32. Chen, Y., and T. Aviad. 1992. The use of bottom coal cinder for growing ornamental plants in container media. Gan Vanof 47:19-20.

33. Inbar, Y., Y. Chen, Y. Hadar, A. Grinberger, and Y. Gilboa. 1993. Fusarium crown-rot in tomato grown in container media in the Jordan Valley: Disease suppression by compost. Hassadeh 73:388-394.

34. Tsvieli, Y., A. Madual, R. Ophenbach, Y. Zabari, R. Dayan, Y. Chen, T. Aviad, Y. Inbar, E. Hadar, Y. Katan, and A. Gamliel. 1993. Recycling of container media for melon production in the Arava. Hassadeh 73:770-773.

35. Chen, Y., and Y. Inbar. 1993. Production of agricultural crops on container media. Gan Sadeh Vameshek 4:23-25.

36. Chen, Y., and Y. Inbar. 1993. Properties of container media used for plant production in greenhouses. Gan Sadeh Vameshek 4:34-36.

Teaching Manuals

1. Singer, A., N. Lahav, E. Rawitz, A. Banin, Y. Chen, J. Navrot, A.Amiel, and M. Gal. 1971. Laboratory manual in soil science. The Hebrew University, Rehovot. 215 + XXVII p.

2. Banin, A., and Y. Chen. 1974. Physical chemistry of the soil. Specialization Course, The Hebrew University, Rehovot. 33 p.

3. Navrot, J., and Y. Chen. 1974. Trace elements in agriculture. A Review. Faculty of Agriculture, Rehovot. 80 p.

4. Banin, A., and Y. Chen. 1975. Water and soil salinity. Specialization Course, The Hebrew University, Rehovot. 46 p.

5. Banin, A., A. Singer, Y. Chen, N. Lahav, J. Navrot, A. Amiel, E. Rawitz, and D. Shaked. 1976. Laboratory manuel in soil science. The Hebrew University, Rehovot. 244 + XXI p.

6. Banin, A., Y. Chen, and D. Shaked. 1978. Soil and Water Salinity. Specialization Course. The Hebrew University, Rehovot. 52 p. + App.

7. Banin, A., and Y. Chen. 1980. Exercises in Soil Science. The Hebrew University, Rehovot. 96 p. + App.

8. Chen, Y., P. Barak, and Y. Inbar. 1983. Methods of soil analysis. Laboratory Teaching Manual. The Hebrew University, Rehovot, 80 p.

9. Chen, Y., P. Barak, and Y. Inbar. 1986. Methods of soil analysis. Laboratory Teaching Manual. The Hebrew University, Rehovot, 200 pp.

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CURRICULUM VITAE

Yoram Avnimelech

Present position

Professor, Water & Soil Sciences, Faculty of Agricultural Engineering, Technion, Israel Inst. of Technology.

Personal

Date and place of birth: [redacted]

Citizenship: Israeli

Marital status: Married + three children

Academic degrees

M.Sc. 1960 Hebrew University, Jerusalem, Faculty of Agriculture.

Ph.D. 1964 Hebrew University, Jerusalem.

Research experience

1959-1960 Studies on the dissolution of calcium phosphates by soil, Hebrew University.

1960-1962 Biological clogging of sands and soil.

1962-1965 Studies on chemistry of phosphorus in soil and on the efficiency of phosphatic fertilizers.

1965-1967 Studies on dissolution and surface properties of Hydroxyapatite, N.B.S., Washington, D.C., USA.

1967-1973 Leader of a team in the Technion working on: Research topics related to fertilizers evaluation development. Transformations of nitrates in peat. Distribution of nitrogenous compounds in soil profiles. Problems related to the pollution of Lake Kinneret.

1973-1977 Head, Lake Kinneret Watershed Research Unit. Research, monitoring and development of management approach related to problems of water quality in Lake Kinneret.

1973-1977 Research on solid waste.

1976-1978 In charge of evaluation of the suitability of the peat from the Hula Valley, Israel, for energy production.

1977-1980 Leader of research project on development of agriculture in mountainous areas.

1979-1980 Research leader, Agricultural Research Organization, Northern Region, Israel

1980-1982 Visiting Soil Scientist, USDA Water Quality Management Lab. Research on aquatic sediments and surface water management.

1982- Studies on sediment-water relationship, water quality, water management, aquaculture, salinity, composting and use of compost. Technion.

1987-1988 Research on environmental biotechnology, Lab of Microbial Ecology, R.U.G, Gent, Belgium

1989-1994 Chief scientist, Ministry of the Environment, Israel. In charge of technical aspects, environmental impact and research in the ministry. Chairman of the council of national parks and natural reserves.

Teaching experience

Courses on soil chemistry, land evaluation, environmental technology.

More than 25 graduate students.

PROFESSOR **YORAM AVNIMELECH**

PROFESSIONAL EXPERIENCE

Academic Education

The academic background of Yoram Avnimelech led to a strong multi-disciplinary background, covering topics from microbiology to physical chemistry, and from agronomy to health studies. Studied agronomy, specialized in Soil Sciences. (Hebrew Univ).

M. Sc. Studies & Thesis - Soil Microbiology

Ph. D. Studies & Thesis - Soil Physical Chemistry (Weizmann Inst. & Hebrew Univ.), Physical Chemistry aspects of soil phosphorus reactions.

Post Doctorate Fellowship - U. S. A. National Bureau of Standards (Presently National Inst. of Science & Technology), Studies on the Physico Chemical aspects of Bone and Teeth structure.

Academic and Professional positions.

Presently - S. Gurney chair and Professor of agricultural Engineering at the Technion, Israel Inst. of Technology.

Held at the Technion positions as head of the Soil & Water Research Laboratory, Head of the Graduate studies committee of soil sciences.

During the period 1974-1977 - Head of the Sea of Galilee Watershed Research unit.

Head of the Mountain Agriculture R & D project 1977-1979.

Head of the Agriculture Research in the Northern part of Israel

1989-1994 Present Chief Scientist of the Israeli Ministry of the Environment. As such in charge of all research conducted and supported by the Ministry, responsible to the inter disciplinary work and committees, represents the Ministry in academic institutions and societies, participates in the Peace talks and serves as the advisor to the Minister.

Positions outside Israel included positions of a research associate in the National Bureau of Standards (USA), in the USDA Water Quality Research Laboratory and a position of visiting professor in the Microbial Ecology Lab in the Univ. of Gent (Belgium). In addition, YA served as a consultant in various development projects in the Philippines and in the Ivory Coast.

Research experience.

Yoram Avnimelech studied and published (More than 100 scientific publications) in a variety of fields, covering the very broad aspects of Environmental Sciences.

1. Physical chemistry of phosphorus

Solubility (e.g. - the presently accepted solubility product of hydroxy apatite), surface reactions, Identification of a surface complex that control solubility of P in calcareous soils and lakes, mobility in the soil.

2. Salinity

Mobility of ions in the soil, development of model simulating the chromatographic migration of cations in the soil.

Salinity problem in the Jesreel valley: Severe salinity symptoms were detected in the valley, known to be one of the fertile regions in Israel. This was attributed to the fact that the valley was managed as a closed system, without ample water and salt drainage. A double tile drainage system, the deeper part of which was designed to drain out salts was installed. The salinity problem was appreciable relieved.

3. Chemistry & Microbiology of Nitrogen in Soils

3.1 It has been shown, as approved later in other countries, that the cultivation of virgin soils was one of the major sources for nitrate enrichment in Israeli soils and ground water.

3.2 A relationship between agricultural intensity and nitrates in ground water was demonstrated.

3.3 The rate of nitrification in soils was measured and formulated. A first order kinetics, to be used later by many scientists was demonstrated.

3.4 Factors controlling denitrification in the soil were studied. The results of these studies were applied in the field, where a a large scale biotechnological approach, leading to an order of magnitude reduction of nitrates in an 2000 ha organic soil watershed was successfully applied. The induction of denitrification, based on the utilization of the microbial burst following the rewetting of dry soil, has lead to a reduction in the nitrogen load to the Sea of Galilee.

4. Aquaculture research

4.1 The reduction in fish pond fertility was attributed to the formation of an anaerobic sediment. The microbial, planktonic and chemical changes following this transition were studied. Means to poise this redox system were proposed.

4.2 An in situ Single Cell Protein (SCP) production system in the pond was developed and shown to be both an effective means to control nitrogen levels in the pond as well as to reduce feed costs to 60% of conventional systems.

4.3 A computer Simulation model developed and published enables the planning of feeding and water exchange regimes.

5. Municipal Solid Waste - Water Pollution & Recycling.

5.1 Water pollution from sanitary land fills models was studied. An exponential decay model that enables to predict the duration of pollution hazard from a landfill was developed.

5.2 Treatment of leachates from sanitary landfills was studied and developed.

5.3 Recycling strategies and alternatives were compared, considering economical and public acceptance criteria.

6. Municipal Solid Waste Composts - Production and Use.

6.1 An extensive study was conducted. Methods for the application of MSW Compost in a way that ensure soil and crop response was developed.

6.2 Technologies for the production of MSW compost were adapted and improved.

6.3 The use of MSW compost for the improvement of saline soils was tested and proven very successful.

The studies listed above led to the development of an MSW Composting plant and to the commercial use of all its production. MSW compost was not acceptable by Israeli farmers before.

7. Development of environmentally friendly slow release fertilizers (SRF)

New formulations of SRF were developed, in cooperation with a fertilizer production company. The mode of action and release rates of these fertilizers were evaluated.

A computer simulation model instructing farmers how to use fertilizers with a minimal leaching of nutrients was developed and is widely used.

8. Turbidity reduction in lakes.

During a Sabbatical stay in the USA Y.A. developed a method to reduce turbidity of lakes as induced by algae - clay interaction.

9. Sea of Galilee Watershed.

Yoram Avnimelech was the head of the Sea of Galilee Watershed Research unit. In this capacity he studied and directed research on a regional basin scale. The different studies involved topics such as River Jordan monitoring and simulation, effects of agriculture on water quality (Fertilizer application, pesticides etc.), erosion, fish ponds, industry and water quality monitoring. In addition he was involved in planning of water ways, management, regulation, education etc.

This work led to a new basin wide water drainage system that reduced the pollution load on the lake, a reduction of phosphorus usage in fish ponds and a general reduction in the nutrient load on the lake.

Teaching

Yoram Avnimelech taught and teaches in courses on soil science, environmental sciences and management, aquaculture etc. Had more than 30 graduate students.

MUNICIPAL SOLID WASTE (MSW) - POLLUTION POTENTIAL, RECYCLING AND COMPOSTS.

LIST OF PUBLICATIONS

A. Sanitary landfills : Pollution and prevention

1. Avnimelech, Y. & A. Raveh. 1979. Decomposition of organic matter in sanitary landfill models. Agronomy Abstracts, p. 25.

2. Raveh, A. & Avnimelech, Y. 1979. Leaching of pollutants from sanitary landfill models. J. WPCF, Vol. 51, No. 11 p. 2705-2716.

3. Raveh, A. & Y. Avnimelech. 1980. Stability of chelates leached from waste disposal sites. Agronomy Abstracts. p. 35.

4. Avnimelech, Y. & Raveh, A.. 1982. Decomposition of chelates leached from waste Disposal Sites. J. Environ. Qual., Vol. 11, no. 1 p. 69-72.

5. M. Green, O. Ayalon, M. Kochba, I. Ravina. 1994. Characterization of sanitary landfill leachates. Final report No.152-744, Ministry of the Environment.

6. Abramovich A. 1994. The Characterizing of Leachates from Sanitary Landfills & Transfer stations and their Treatment. M.Sc. Final Paper, 78p. (Hebrew, Eng. Abs.)

B. Production and utilization of MSW composts

7. Avnimelech, Y. Organic residues in modern agriculture. 1986 In: Chen, Y. and Y. Avnimelech (Eds). The role or organic matter in intensive agriculture. Martinus Nijhoff Publ., Dordrecht, The Netherlands, pp. 1-10.

8. Livneh, Y. 1987. Optimization of compost application. M. Sc Thesis, 122p. (Hebrew, Eng. Abs.)

9. Avnimelech, Y. and A. Cohen. 1988. On the use of organic manures for amendment of compacted clay soils: Effects of aerobic and anaerobic conditions. Biological Wastes 26: 331-339.

10. Avnimelech, Y. and A. Cohen. 1988.
The effects of aeration and of C/N ratios on the efficiency of manuring (Hebrew). Hassadeh, 68: 1175-1191.

11. Shkedy, D., A. Cohen and Y. Avnimelech. 1988.
Using compost to increase soil fertility (Hebrew). Hassadeh, 68: 1798-1802.

12. Avnimelech, Y. & A. Cohen. 1989. Use of organic manures for amendment of compacted clay soils - II. Effect of carbon to nitrogen ratio. Commun. in Soil Sci. Plant Anal., 20(15&16), 1635-1644.

13. Yotal, Y., M. Kochba, D. Shkedy, Y. Yarmot and Y.Avnimelech. 1989.
The use of compost and gypsum for the reclamation of saline and alkaline soils (Hebrew). Hassadeh, 69: 2077-2079.

14. Avnimelech, Y., A. Cohen & D. Shkedi. 1990.
The effect of municipal solid waste compost on the fertility of clay soils. Soil Technology, Vol. 3, pp. 275-284.

15. Avnimelech, Y., M. Kochba, Y. Yotal & D. Shkedi. 1990.
On the use of municipal solid waste compost for the reclamation of saline and alkaline soils. TRANS. of 14th Interna. Congress of Soil Science. Vol. IV, 186-191, Kyoto, Japan.

16. Mor Y., S. Gilboa S., M. Kochba, Y. Avnimelech and H. Orly. 1990.
Maize fertilization in the Jordan Rift Valley (Hebrew). Hassadeh, 70.

17. Ayalon O., Nishri A., Avnimelech Y. 1991.
Distribution of soluble iron and zinc in leachates of municipal wastes. In: Y. Chen and Y. Hadar (Eds.) Iron nutrition and interactions in plants, Kluwer academic publishers, p. 53-56.

18. Avnimelech, Y., Kochva, M., Yotal, Y. and Shkedy D. 1992.
The use of compost as a soil amendment. Acta Horticulturae p. 217-236.

19. Avnimelech Y., Cohen A., Shkedy D. 1993.
Can we Except a Consistent Efficiency of MSW Compost Application? Compost Science & Utilization ,Autumn 1993, p. 7-14.

20. Avnimelech Y., Kochva M., Yotal Y. 1994.
The use of MSW Compost for the Reclamation of Saline & Alkaline Soils Compost Science & Utilization, In Press.

C. Recycling, Economy and Management of MSW.

21. Ayalon O. 1993 .
Collection and Recycling of Municipal Solid Waste-
Analyses of alternatives. Final Paper, 95p. (Hebrew, Eng. Abs.)

22. Ayalon O., Shechter M. and Avnimelech Y. 1994.
Collection and Recycling of Municipal Solid Waste-
Analyses of alternatives. The S. Neaman Inst. for Advanced Studies in science and Technology. ISBN- 965-386-017-8 , 103 p.
(Hebrew, Eng. Abs.)

23. Shechter M. and Ayalon O. 1993
Recycling Policy for MSW- Analyses of alternatives.
Final report , Ministry of the Environment.

January 1995

YITZHAK HADAR

CURRICULUM VITAE

Personal

Date and Place of birth:	[redacted]
Nationality:	Israeli
Marital Status:	Married with 3 children

University Degrees

1976	- B.Sc. with distinction: The Hebrew University of Jerusalem, Faculty of Agriculture, Rehovot.
1977	- M.Sc. with distinction: The Hebrew University of Jerusalem, Faculty of Agriculture, Rehovot. Thesis: Biological control of *Rhizoctonia solani* by *Trichoderma harzianum*.
1981	- Ph.D. Thesis. The Hebrew University of Jerusalem, Faculty of Agriculture, Rehovot. Thesis: Morphogenetic studies of the fungus *Sclerotium rolfsii*.

Research and Professional Experience

1977-1980	- Research and teaching assistant of plant pathology and microbiology.
1980-1981	- Instructor of plant pathology and microbiology.

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1981-1982	- Post Doctoral Associate, Cornell University, Department of Seed and Vegetable Sciences.
1982-1985	- Lecturer of Microbiology, Faculty of Agriculture, Rehovot.
1985-1986	- Member of the Board of the Israeli Phytopathological Society.
1985-1990	- Senior Lecturer of Microbiology, Faculty of Agriculture, Rehovot.
1987	- Member, Organizing Committee of the Second Otto Warburg Symposium on "Plant Microorganism Interaction in the Rhizosphere".
1987&1988-1992	- Chairman, Teaching Program in Plant Protection, Faculty of Agriculture.
1987-1990	- Member, Library Committee, Faculty of Agriculture, Rehovot.
1989	- Member, Organizing Committee of the 5th International Symposium on "Iron Nutrition and Interactions in Plants".
1988-1989	- Visiting Scientist at Repligen - Sandoz Research Corporation, Lexington, MA, USA.
1989- to date	- Member, Directing Committee of the Otto Warburg Center for Biotechnology in Agriculture.
1990	- Member, Organizing Committee of the Binational Spain-Israel Symposium on Biotechnology.
1990	- Member, Organizing Committee of the Binational Belgium-Israel Symposium on "Plant growth substrates and their biology".
1990- 1992	- Chairman, Audio Visual Center, Faculty of Agriculture.
1990- 1992	- Member, Committee of "Binational Agriculture Research and Development Foundation (BARD) and Ministry of Agriculture, for reviewing grant proposals in plant protection.
1991	- Chairman and Organizer of a session on "Environmental Microbiology" in the Annual Meeting of the Israeli Microbiological Society, March 25-26, 1991.

1991-1994	- Member of the Subcommittee for Agriculture and Applied Biology for Ph.D. students. The Hebrew University of Jerusalem.
1991-1992	- Member of the Equipment Committee, Faculty of Agriculture, The Hebrew University of Jerusalem.
1991	- Associate Professor in Microbiology.
1992-to date	- Member of the Research Committee, Faculty of Agriculture.
1993-to date	- Chairman, Sport and Recreation Center, Faculty of Agriculture.
1993-to date	- Coordinator, teaching program of 'Environmental Quality and Agriculture' Faculty of Agriculture.
1993	- Member, Organizing Committee, 10th Anniversary Symposium, "Molecular Biology in Plant Breeding: Theoretical, Practical and Legal Aspects, March 21-24, 1994. Otto Warburg Center for Biotechnology In Agriculture, Faculty of Agriculture
1993	- Member, Organizing Committee of the International Symposium, "Modern Agriculture and the Environment".To be held in Rehovot, October 1994.
1994	- Member, Program Committee of the meeting of the International Union of Mycological Societies, Jeruslem, 1996.
1994	- Member, The Hebrew University Steering Committee for Envieronmental Studies.
1994	- Member, The Board of Directors of the Authority of Research and Development of the Hebrew University.
1994	- Member, The Ministry of Science and the Arts Commission for Infrastructure in Biotechnology.
1994	- Professor of Microbiology.

Prizes and Awards

1977	- The Kurtz Prize for research on The Prevention of Environmental Hazards.
1979	- The Kadma Prize for Plant Protection.
1981	- Recipient of the Lady Davis Fellowship for Postdoctorate studies.
1982	- The A.Z. Cohen Prize for Plant Protection.
1982-1985	- Revson Fellow, The Faculty of Agriculture.
1985-1986	- Mauricio Richter Fellow, The Faculty of Agriculture.
1990	- Recipient of the "Joseph H. and Belle R. Braun Lectureship".
1993	- Recipient of A.D. Bergman research grant for distinct applied science.

Teaching

Teaching the following courses:

1. Laboratory course in General Microbiology.
2. Environmental Microbiology.
3. Biotechnological Process in Agriculture.
4. Seminar in Biotechnology.
5. Workshop on Microorganisms in Food Production.
6. Recycling of Municipal and Agricultural Wastes.
7. Environmental Quality in Israel - Workshop.
8. Seminar in Plant Protection.

<u>Graduate Student Supervision Activities</u>

1. Completed Thesis:

   Supervised 15 students towards their M.Sc. thesis.
   Supervised 3 students towards their Ph.D. thesis.

2. Presently supervising 7 Ph.D. students and 8 M.Sc. students

Grants (last 5 years)

Competitive Grants:

1.US-Israel Binational Agricultural Research and Development Fund (1990-1994) $270,000

2.US-Israel Binational Agricultural Research and Development Fund (1992-1996) $280,000

3.Volkswgen Foundation (1993-4) 40,000 DM

4. AID-CDR with Ghana(1991-6) $200,000

5. AID-CDR with The Czech Republic (1993-8) $200,000

6.Dutch Israel Agricultural Research Program (DIARP) (1993-6) 200,000 IS

7.European Community with Germany (1993-7) 180.000 ECU

8. Ministry of the Envieronment (1993-5) 100,000 IS

Hebrew University Research and Development Authotity related grants:

1.Ministry of Baden-Vurrtemberg for Science- Hohenhiem University, Germany (1990-1995) 120,000DM

2. A.D. Bergman research grant for applied science (1993-1995)$ 40,000

January 1995

YITZHAK HADAR

LIST OF PUBLICATIONS

Dissertations

1. Hadar, Y. 1977. M.Sc. Thesis. Biological control of *Rhizoctonia solani* by*Trichoderma harzianum*. Hebrew University of Jerusalem.

2. Hadar, Y. 1981. Ph.D. Thesis. Morphogenetic studies of the fungus *Sclerotium rolfsii*. Hebrew University of Jerusalem.

Book

3. Chen, Y. and Hadar, Y. (eds.). 1991. Iron Nutrition and Interactions in Plants. Martinus Nijhoff, Kluwer Academic Publishers, Amsterdam, 377 pp.

Invited Reviews and Chapters in Books

4. Chet, I., Hadar, Y., Elad, Y., Katan, J. and Henis, Y. 1979. Biological control of soilborne plant pathogens by *Trichoderma harzianum* . pp. 589-591. In: B. Schippers and W. Gams (eds). Soil Borne Plant Pathogens. Academic Press.

5. Chen, Y., Hadar, Y. and Inbar, Y. 1986. The use of composted agricultural waste as peat substitute in horticulture. pp.388-392. In: P. L'Hermite (ed.). Processing and Use of Organic Sludge and Liquid Agricultural Wastes. Reidel Publishing Company, Boston.

6. Hadar, Y., Jurkevitch, E. and Chen, Y. 1986. The effect of *Pseudomonas* on iron nutrition of plants. pp. 43-48. In: T. R. Swinburne (ed.). Iron, Siderophores and Plant Disease. Plenum Press, New York.

7. Hadar, Y. 1986. The role of organic matter in the introduction of biofertilizers and biocontrol agents to soils. pp. 169-179. In: Y. Chen and Y. Avnimlech (eds.). The Role of Organic Matter in Modern Agriculture. Martinus Nijhoff, Kluwer Academic Publishers, Amsterdam.

8. Chen, Y. and Hadar, Y. 1987. Composting and use of agricultural wastes in container media. pp. 71-77. In: M. De Bertoldi, M.P. Peranti, P. L'Hermite and F. Zucconi (eds.). Compost: Production, Quality and Use. Elsevier Science Publishers, New York.

9. Okon, Y. and Hadar, Y. 1987. Microbial inoculants as crop yield enhancers. CRC Critical Reviews in Biotechnology 6:61-85.

Since last appointment

10. Hadar, Y. and Dosoretz C.G. 1991. Mushroom mycelium as potential source of food flavor.Trends in Food Science and Technology 2:214-218.

11. Hadar, Y., Mandelbaum, R. and Gorodecki, B. 1992. Biological control of soilborne plant pathogens by suppressive compost. In: E.C. Tjamos, G.C. Papavizas and R.J. Cook (eds.). Biological Control of Plant Disease: Progress and Challenge for the Future, Plenum Press 79-83.

12. Inbar, Y., Chen, Y., Hadar, Y. and Hoitink, H.A.J. 1992. Approaches to determining compost maturity. In: The Biocycle Guide to the Art and Science of Composting, J.G. Press, Inc., Emmaus, Pennsylvania, 183-187.

13. Chet, I. and Hadar, Y. 1992. Future directions and potential of agricultural biotechnology. pp. 11-20. Proceedings of the International Seminar on Impact of Biotechnology in Agriculture and Food in Developing Countries. Madras, India. ICSU, COSTED and ABNS, 264 pp.

14. Hoitink, H.A.J., Boehm, M.J. and Hadar, Y. 1993. Mechanism of suppression of soilborne plant pathogens with compost. In: H.A.J. Hoitink (ed.). Science and Engineering of Composting, Renaissance Publications , Worthington, Ohio pp.601-621.

15. Chet, I., Inbar, J. and Hadar, Y. 1994. Biocontrol strategies - fungal antagonists and mycoparasites. In: D.T. Wicklow and B.E. Soderstrom (Eds.). The Mycota, Vol. 5, Environmental and Microbial Relationships. (in press).

Articles in Scientific Journals

16. Hadar, Y., Chet, I. and Henis, Y. 1979. Biological control of *Rhizoctonia solani* damping-off with a wheat bran culture of *Trichoderma harzianum*. Phytopathology 69:64-68.

17. Hadar, Y., Henis, Y. and Chet, I. 1981. The potential for the formation of sclerotia in submerged mycelium of *Sclerotium rolfsii*. J. Gen. Microbiol. 122:137-141.

18. Elad, Y., Hadar, Y., Hadar, E., Chet, I. and Henis, Y. 1981. Biological control of *Rhizoctonia solani* by *Trichoderma harzianum* in carnation under field conditions. Plant Disease 65:675-677.

19. Hadar, Y., Elad, Y., Chet, I. and Henis, Y. 1982. Induction of macroscopic strands formation in *Sclerotium rolfsii* by *Trichoderma harzianum*. Isr. J. Bot. 30:156-164.

20. Elad, Y., Hadar, Y., Chet, I. and Henis, Y. 1982. Prevention of re-infestation of methyl bromide fumigated soil and improvement of disease control by *Trichoderma harzianum*. Crop Protection 1:199-211.

21. Hadar, E., Elad, Y., Hadar, Y. and Chet, I. 1982. Build up and decline of *Rhizoctonia solani* inoculum under field conditions. Plant and Soil 65:303-307.

37. Platt, M.W., Hadar, Y. and Chet, I. 1985. The decolorization of the polymeric dye poly blue (Polyvinalamine sulfonate - Anthroquinone) by lignin degrading fungi. Appl. Microbiol. Biotech. 2:394-396.

38. Hadar, Y., Inbar, Y. and Chen, Y. 1985. Effect of compost maturity on tomato seedling growth. Sci. Hort. 27:199-208.

39. Zeidan, O., Elad, Y., Hadar, Y. and Chet, I. 1986. Integrating onion in crop rotation as a means of controlling *Sclerotium rolfsii* . Plant Disease 70:426-428.

40. Hadar, Y. and Mandelbaum, R. 1986. Suppression of *P. aphanidermatum* damping-off in container media containing composted licorice roots. Crop Protection 5:88-92.

41. Inbar, Y., Chen, Y. and Hadar, Y. 1986. The use of composted cattle manure and grape marc as peat substitutes in horticulture. Acta Hort. 178:148-154.

42. Jurkevitch, E., Hadar, Y. and Chen, Y. 1986. The remedy of lime induced chlorosis in peanuts by *Pseudomonas* sp. siderophores. J. Plant Nut. 9:535-547.

43. Hadar, Y. and Cohen-Arazi, E. 1986. The chemical composition of the edible mushroom *Pleurotus ostreatus* produced by fermentation. Appl. Environ. Microbiol. 51:1352-1354.

44. Jurkevitch, E., Chen, Y. and Hadar, Y. 1987. The role of bacterial siderophores in the iron nutrition of plants. Soil Sci. Soc. Am. J. 52:1032-1037.

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Lectures and Abstracts of Papers presented at National and International Conferences

Before last appointment - 34

After last appointment - 16 (6 as invited lecturer)

ANNEX III

REPORT FORMATS

PROGRESS REPORT ON RECYCLING OF BIODEGRADABLE WASTE

I. Title Page: should be formatted as follows:

1. Name of Organization (Ministry/University and office)
2. Reporting period dates
3. Subject Project Title
4. Performing Institutions (mention primary institution first, then supporting institution[s])
5. Project Coordinator(s) and technical staff

II. Executive Summary - summarize major objectives for this reporting period, which objectives were achieved and problems encountered. Discuss what was achieved during this reporting period at the institutional level, and at the local and regional level.

III. Main Report

1. Accomplishments: list. These should not be more than one or two lines each and should address accomplishment of project goals as delineated in the annual plan. Please write these to a non-technical or semi-technical audience. Conclude with a brief paragraph on the most significant result to date.

2. Personnel changes: if the project adds or eliminates staff positions, please note here.

3. International Travel: include trips to/from Egypt/Israel. It is preferable to list the person's title (his or her position in this project) rather than name, unless the person has been identified elsewhere in the current report (such as the title page).

4. Meetings and collaboration activities: this part should describe what took place during travel (no. 3). This may also include other activities already in progress when the reporting period began (such as a long term visit by scientist or technician to another institute).

5. Publications produced by the project staff. Please list, and if possible, include a photocopy or reprint as an appendix.

6. Plans for the next six months. Please list <u>the objectives</u>, what activities will be continued from the current period, and what will be added or changed, projected travel, procurements, and - if possible - presentations and publications. <u>Please note: it is not enough to say that the workplan will be followed</u>. Please list how you will determine that the objectives have been met.

7. Problems: describe problems encountered, including problems that are insurmountable within the context of this project. Please list any recommendations for alternative actions or activities that may be pursued to overcome problems or redirect the project workplan.

8. Assessment of Cooperation and Impact of Research: very important. Please address how regional cooperation has influenced the success or non-success of the project's progress. A paragraph describing what impact this project has had on the local and regional entities.

Please fax your reports to Dr. Harry Hoitink, Ohio State University, FAX 1-**216-263-3841**.

REPORT FOR 1. DATA SURVEY & EVALUATION Period Covered:_____							
Institution: _____	Budget	Funds Disbursed	Total Funds	Funds Remaining	Projected Disbursements:		Other/In-kind
_____	Available	this Quarter	Disbursed	Available	Next 6 months	Next 12 months	Contributions
1. Personnel							
Technical Leader (_____%) x ?							
Technicians/Scientists f							
on staff (_____%) x ?							
Research Assistant/Field							
Personnel (_____%) x ?							
Support Staff (____%) x ?							
Subtotal:							
2. Travel - Regional/Local							
3. Travel - Other							
4. Supplies/expendable materials							
5. Equipment (depreciable - list)							
a.							
b.							
c.							
d.							
Subtotal equip. costs:							
6. Other miscellaneous (list)							
a. Publications							
b.							
c.							
Subtotal Misc Costs:							
7. Subtotal Direct Costs:							
8. Overhead (14% - MERC)							
9. Total Direct & Indirect Costs:							

REPORT FOR 2. ECONOMIC & MARKET ANALYSIS			Period Covered: _____				
Institution: _____	Budget	Funds Disbursed	Total Funds	Funds Remaining	Projected Disbursements:		Other/In-kind
_____	Available	this Quarter	Disbursed	Available	Next 6 months	Next 12 months	Contributions
1. Personnel							
Technical Leader (_____%) x ?							
Administrative Leader (_____%)							
Admin staff (_____%) x ?							
Research Assistant/Field							
Personnel (_____%) x ?							
Support Staff (____%) x ?							
Subtotal:							
2. Travel - Regional/Local							
3. Travel - Other							
4. Supplies/expendable materials							
5. Equipment (depreciable - list)							
a.							
b.							
c.							
d.							
Subtotal equip. costs:							
6. Other miscellaneous (list)							
a. Publications							
b.							
c.							
Subtotal Misc Costs:							
7. Subtotal Direct Costs:							
8. Overhead (14% - MERC)							
9. Total Direct & Indirect Costs:							

REPORT FOR 3. TRAINING/PROF. DEVELOPMENT: SUMMARY							
Institution: _____	Budget	Funds Disbursed	Total Funds	Funds Remaining	Projected Disbursements:		Other/In-kind
_____	Available	this Quarter	Disbursed	Available	Next 6 months	Next 12 months	Contributions
1. Personnel							
--Already allocated within other							
other budgets							
Subtotal:							
2. Travel to & in the U.S.							
3. Maintenance in the U.S.							
(3 persons for 6 months per yr).							
4. Supplies/expendable materials							
5. Equipment (depreciable - list)							
a.							
b.							
c.							
d.							
Subtotal equip. costs:							
6. Other miscellaneous (list)							
a. Publications							
b.							
c.							
Subtotal Misc Costs:							
7. Subtotal Direct Costs:							
8. Overhead (14% - MERC)							
9. Total Direct & Indirect Costs:							

REPORT FOR 4. RAPID TECH TRANSFER & DEMONSTRATION SITES				Period Covered: _____			
Institution: _____	Budget	Funds Disbursed	Total Funds	Funds Remaining	Projected Disbursements:		Other/In-kind
_____	Available	this Quarter	Disbursed	Available	Next 6 months	Next 12 months	Contributions
1. Personnel							
Technical Leader (_____%) x ?							
Technicians/Scientists f							
on staff (_____%) x ?							
Research Assistant/Field							
Personnel (_____%) x ?							
Support Staff (____%) x ?							
Subtotal:							
2. Travel - Regional/Local							
3. Travel - Other							
4. Supplies/expendable materials							
5. Equipment (depreciable - list)							
a.							
b.							
c.							
d.							
Subtotal equip. costs:							
6. Other miscellaneous (list)							
a. Publications							
b.							
c.							
Subtotal Misc Costs:							
7. Subtotal Direct Costs:							
8. Overhead (14% - MERC)							
9. Total Direct & Indirect Costs:							

REPORT FOR 5. TECHNOLOGY IMPROVEMENT			Period Covered: _____				
Institution: _____	Budget	Funds Disbursed	Total Funds	Funds Remaining	Projected Disbursements:		Other/In-kind
_____	Available	this Quarter	Disbursed	Available	Next 6 months	Next 12 months	Contributions
1. Personnel							
Technical Leader (_____%) x ?							
Technicians/Scientists f							
on staff (_____%) x ?							
Research Assistant/Field							
Personnel (_____%) x ?							
Support Staff (____%) x ?							
Subtotal:							
2. Travel - Regional/Local							
3. Travel - Other							
4. Supplies/expendable materials							
5. Equipment (depreciable - list)							
a.							
b.							
c.							
d.							
Subtotal equip. costs:							
6. Other miscellaneous (list)							
a. Publications							
b.							
c.							
Subtotal Misc Costs:							
7. Subtotal Direct Costs:							
8. Overhead (14% - MERC)							
9. Total Direct & Indirect Costs:							

REPORT FOR 6. U.S. PARTICIPATION		Period Covered:					
Institution:	Budget	Funds Disbursed	Total Funds	Funds Remaining	Projected Disbursements:		Other/In-kind
	Available	this Quarter	Disbursed	Available	Next 6 months	Next 12 months	Contributions
1. Personnel							
Technical Leaders							
Technicians/Scientists							
on staff							
Research Assistant/Field							
Personnel							
Support Staff							
Subtotal:							
2. Travel - Regional/Local							
3. Travel - Other							
4. Supplies/expendable materials							
5. Equipment (depreciable - list)							
a.							
b.							
c.							
d.							
Subtotal equip. costs:							
6. Other miscellaneous (list)							
a. Publications							
b.							
c.							
Subtotal Misc Costs:							
7. Subtotal Direct Costs:							
8. Overhead (OSU, ARS)							
9. Overhead (ICD Retained)							
10. Total Direct & Indirect Costs:							

ANNEX IV

INSTITUTIONAL CAPABILITIES

AND

RESOURCES INFORMATION

Solid Waste Technology at The Ohio State University; Interactions with Industries

The Ohio State University has interacted with various industries in the development of solid waste treatment technologies since the early seventies. This report emphasizes the history of developments at OSU in this field. Details of future directions are summarized in the attached description of OSU' Solid Waste Technology Program (Appendix I).

Human and animal health related activities, which include risk-assessment, are a component of this program, although this is not reviewed in this Program Description. Fourteen faculty members contribute to this solid waste effort. Several have supported the development of systems operating throughout the world today.

The following is a brief summary of principal approaches to waste treatment developed at OSU in cooperation with industry.

1. **Municipal Sewage and Papermill Sludges:**

During the early eighties a feedback controlled in vessel composting system was developed that eradicates fecal pathogens and parasites while yielding a stabilized product beneficial to agriculture (Kuter et al, 1985; Kuter et al, 1988). Several US companies are marketing technologies based on this process.

OSU's research and development efforts in this field today focus on 1) cost reduction and odor minimization through improved engineering design strategies (Keener et al, 1993; Keener et al, 1995) and 2) the preparation of value-added products through inoculation of composts with microorganisms providing natural biological control of plant diseases (Grebus et al, 1994a and b).

Registration of this novel approach to control of diseases is being pursued with US-EPA in cooperation with industry. This product will eliminate the use of hazardous pesticides such as methyl bromide, reduce fungicide use and improve the quality of agricultural products. This applies particularly to high value ornamental crops (Hoitink et al, 1991).

In some localities, carbon sources are not readily available for treatment of low C/N wastes such as sewage sludges. For these regions, OSU has assisted in the development

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of a lime/stabilization/composting process widely used in the world today (Burnham et al, 1992). This process yields a product that is a blend of lime and stabilized sludges free of pathogens and parasites that is suitable for application to agricultural land.

2. **Municipal Solid Wastes; Yard wastes, Food wastes, etc.**

The kinetics of decomposition for many types of wastes have been characterized at OSU (Tseng et al, 1995; Keener et al, 1995). Out of doors as well as in-vessel-composting technology, that is under feed back process control, has been developed for treatment of most of these wastes (Marrugg et al, 1993; Grebus et al, 1994; Keener et al, 1995). Only the early stages of these processes, when rates of decomposition are highest, are controlled. Later stages are performed in lower operating cost windrows or contiguous piles.

Several of these systems, ranging from enclosed to open, are operating in Ohio. Some are located in densly populated areas and operate without problems revealing that odor generation is minimized effectively (Marugg et al, 1993).

Value-added products for use in vegetable, ornamental and turf production are being developed from these composts in cooperation with several industries in Ohio and other States (Boehm et al, 1993; Grebus et al, 1994).

Several SWT Program faculty members are interacting with industries to develop further refinements of mixed municipal solid waste separation and composting systems (Iannotti et al, 1994; Hoitink et al, 1995). Emphasis in this work is on 1) removal of heavy metals and inerts through manual as well as mechanized sorting approaches (He et al, 1993; Hoitink et al, 1993; Hoitink et al, 1995) and 2) refinement of the kinetics of the process to reduce odors and decrease retention times as well as total costs. The fates of biodegradable gels and plastics is being tested also.

3. **Farm manures and other agricultural solid wastes:**

Efforts are underway to develop odor-free poultry farms yielding a stabilized pelletized organic fertilizer. Although this is an old concept, major practical applications must be made to remove odors surrounding both the animal housing as well as the composting facilities. In cooperation with industry, total air handling systems are being tested in cooperation with industry for these facilities in full-scale operations.

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4. **Bioremediation of contaminated soils**:

Several members of OSU's SWT Program (W. A. Dick, O. H. Tuovinen, S. J. Traina, T. J. Logan) have performed research on the biodegradation of pesticides and other soil contaminants. OSU interacts with several industries in remediation of contaminated soils surrounding former pesticide manufacturing facilities. Remediation of abandoned mined lands with byproducts from solid wastes has been performed since 1972 in a variety of applications. (Pichtel and Dick, 1991a and b).

References:

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Tseng, D. Y., Chalmers, J. J., Tuovinen, O. H. and Hoitink, H. A. J. 1995. Characterization of a bench-scale system for the biodegradation of solid wastes. Biotechn. Progress (In Press).

THE OHIO STATE UNIVERSITY - SOLID WASTE TECHNOLOGY PROGRAM

BACKGROUND INFORMATION:

Solid waste management is causing concerns throughout the world. Our future to a significant degree is determined by how this issue is addressed. Industries, municipalities and agriculture all are affected. Today, industries recognize that new products must be designed from "cradle to the grave" to reduce or avoid disposal problems. Municipalities will need to reduce costs associated with waste treatment processes to meet projected decreased revenues from society. Agriculture will need to solve odor problems produced by some systems. In some areas alternatives to direct land application of solid wastes must be developed. The Netherlands and parts of Germany serve as examples for having developed highly efficient agricultural systems that are now collapsing because of inadequate focus on solid waste issues.

The goal of an ideal waste management strategy is to reduce or eliminate environmental and economic constraints associated with solid waste disposal without raising costs to society. This goal is best pursued by emphasizing: 1) reduction; 2) reuse; 3) recycling; 4) the introduction of biodegradable materials and; 5) the production of new value-added products from solid wastes. Education and research play major roles in these endeavors.

Restrictions on burning, incineration and landfilling, as well as an amendment of the Resource Recovery Act (Executive Order 12780, October 31, 1991), have moved the nation in the direction of composting as the preferred strategy for treatment of biodegradable organic solid wastes that cannot be recycled or reutilized. The same strategy is available for agriculture, particularly in those regions where solid wastes are produced in excessive quantities. With the shift to composting, materials (composts) increasingly are becoming available from which new products can be developed. For some waste streams, however, adequate technology is not available and fundamental research is justifiable.

During the past two decades, The Ohio State University has made significant contributions to the development of technologies for waste treatment and utilization through its research on composting. Alternative approaches have been developed for municipal, and industrial as well as agricultural by-products. However, significant opportunities remain for the development of new industries and the removal of constraints to growth.

OSU Extension plays an important role in solid waste management. This reputation extends to policy and public awareness/understanding. The activity mission of the Solid Waste Technology Program (SWTP) is to foster the development and application of new concepts and activities in this field of environmental sciences.

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Since 1980, over 1 billion dollars have been invested in systems for composting of wastes such as sewage sludges, municipal solid wastes, manures, fermentation wastes, etc. In spite of this large capital investment, odors and high operating costs plague many facilities. Several composting plants ($30-$50 million dollar construction cost per location) have been closed after operating only a very short time. In some cities, odors limit development in adjacent areas near municipalities. One "solution" to odors has been to operate poorly designed plants at reduced capacities and retrofit with chemical scrubbers that function at great cost to investors and/or tax payers. Unfortunately, this approach does not address the basic problems: *A lack of 1) fundamental understanding of rates at which varies substrates become available to microorganisms during the process and 2) knowledge required to solve the problem at an affordable cost.*

Composting plants that cannot maintain predominantly aerobic conditions throughout the process produce odors and composts lacking in stability. Such immature composts inhibit plant growth and enhance diseases caused by soilborne plant pathogens. They are difficult to utilize beneficially and are landfilled frequently.

Lack of knowledge of rates of bioavailability of various ingredients (substrates) in compost makes system design an art rather than what it should be: a predictive engineering science. For example, lack of ability to predict rates of decomposition early in the process frequently leads to fermentation. The organic acids produced cause odors and lower rates of decomposition. Organic acids also extract heavy metals from the surface of metallic contaminates in solid wastes. A properly designed facility could prevent such materials from contaminating the end product and, ultimately, the environment. Thus, major opportunities for the development of new composting technologies exist. However, transfer of existing knowledge to design teams in industry is equally important.

Mechanical aspects of composting systems need attention. Composts prepared from mixed municipal solid wastes (MSW) frequently are contaminated by "sharps" (glass, etc.) and non-biodegradable components (plastic films, etc.) rendering them unsuitable for utilization in agriculture. The system of processing in MSW plants has a significant impact on product quality and, therefore, potential for contamination of treated soils with inerts. Significant opportunities for design improvements exist in this field of engineering. Adult education of design engineers and operators of what is unacceptable as contaminants in composts is critical to implementation of solutions to this problem.

Prediction of rates at which essential plant nutrients (N, P, K, etc.) are released from composts during utilization is difficult, even though this significantly affects utilization. The available carbon to nitrogen ratio is the most important factor. Composts that excessively immobilize N (high C/N) have a tendency to cause crop failures. On the other hand, low C/N composts enhance some plant diseases. Lack of predictive information in this field increases rather than decreases costs and also pesticide use. Standards for determination of nutrient values (N,P,K, etc) in compost must be investigated, therefore. Although diversion of yard and food wastes from landfills is progressing rapidly, the production of high quality composts from these

products is lagging because of the lack of knowledge in this field. ***Thus, production agriculture hesitates to utilize compost for valid reasons.***

Soils and lake sediments contaminated with pesticides or hazardous biodegradable substances increasingly are bioremediated through composting. It is the least costly and safest solution to many such problems. In some polluted soils near industrial sites concentrations of volatile toxic substances are so high that venting into the air is not feasible. Entirely new composting technology needs to be developed here. OSU's SWTP is assisting industries in this field, which is critical to lowering production costs for an increasing number of organic materials.

Major opportunities exist for the development of new products from composts. Composting systems that meet process parameters have the potential to produce products that suppress diseases and promote plant growth. Such products, if inoculated with beneficial microorganisms, provide biological control of plant diseases and improve physical and chemical properties of soils. New industries are being developed on the basis of this technology for which OSU holds patents.

Just as the horticultural and agricultural industries have benefited from composts, the animal industries also have the opportunity to benefit from biological control of certain diseases. Strategies could be developed for the production of compost-amended feeds, animal bedding and litter that suppress animal pathogen population development. This in turn will improve animal health and reduce product contamination. It may also lead to reduced use of antibiotics in this industry. The potential for improved efficiency in animal production is significant.

Present trends in the re-direction of solid waste treatment through composting reveal that total costs to society will be reduced and employment increased. For example, composting of yard wastes (including grass clippings, leaves, brush and trees) costs $6 - $25.00/ton. The sale price of composts produced from these wastes ranges from $10.00 to $50.00/ton, depending upon quality of compost and product acceptability. Increased knowledge of the process and product and application of better technology will improve quality and therefore acceptance of compost. This, in turn, will decrease up front costs associated with solid waste recycling. Back yard (home) composting of some of these wastes, which is even less costly in some areas, must be stimulated where feasible through adult education programs.

In conclusion, progress in solid waste recycling depends on many factors. The overall success is determined by our ability to: 1) separate biodegradable from toxic and non-biodegradable products in the waste stream, 2) characterize rates of decomposition of various substrates and the products formed as a function of process environment, 3) create an environment which is controlled and capable of meeting the demands of the process, thereby increasing stabilization rates and preventing odor generation, and 4) develop an understanding of how compost and the associated microflora interact during both compost production and utilization so that beneficial utilization becomes predictable. Knowledge of the goals of waste treatment and the pathways to achieve these goals will allow effective construction and operation of plants and the development of new products and the removal of limits to expansion of certain industries.

Significant opportunities remain for reducing direct as well as indirect costs associated with recycling of solid wastes. In conclusion, the SWTP plans to develop composting and related activities as a lower in cost, and more environmentally sound alternative to present options, thus allowing growth in both employment and production through removal of environmental constraints.

Description of the Solid Waste Technology Program

The SWTP serves as a model for research, extension and educational needs in the areas of solid waste management through composting. It also serves as a major outreach facility for research and demonstration projects to municipal, industrial and animal solid waste industries. It is available for the development of new innovative technologies for the conversion of by-products into value-added new products.

Engineering design parameters for composting systems will be developed in Agricultural and Biological Engineering and Animal Sciences. A new Composting Facility will be completed by July, 1996. It will house pilot-scale computer-controlled composting and curing systems equipped with biofilters and instrumentation for analysis of exhaust gases. The kinetics of the destruction of substances, during processing of contaminated solid wastes will be emphasized in Chemical Engineering at OSU, in cooperation with Microbiology and Natural Resources. Advanced Spectroscopic techniques for characterization of the degradation of hazardous and or complex substances will be centered in Natural Resources and Chemical Engineering. Procedures for preparation of composts inoculated with biocontrol agents that predictably control diseases will be developed in Plant Pathology and Animal Sciences. Utilization strategies will be developed in Natural Resources and Horticultural and Crop Science. All of these activities are highly interdisciplinary in nature. The responsibility for adult education lies with OSU Extension. However, faculty active in research, OSU Extension, and undergraduate as well as graduate education, play major roles in these activities.

Mission of the Program

The mission of the Program is to:

1. Provide the infrastructure for performing research, educational and extension activities leading to the development of economically and environmentally sound procedures for the conversion of solid wastes into value-added products.

2. Foster relationships between academia, governmental agencies and industry leading to the development and application of appropriate solutions to solid waste problems.

3. Facilitate in-service training for university, government and industry personnel in new technologies for management and utilization of solid wastes.

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4. Provide personnel (faculty, undergraduate, graduate students, etc.) to cooperate with industry in research and educational activities.

Program Faculty

H. A. J. Hoitink, SWTP Leader and Professor, Plant Pathology, Wooster
J. J. Chalmers, Assoc. Professor, Chemical Engineering, Columbus
W. A. Dick, Professor, Natural Resources, Wooster
J. E. Heimlich, Assist. Professor, Community Development, Columbus
J. W. Johnson, Professor, Natural Resources, Columbus
H. M. Keener, Assoc. Professor, Agricultural and Biological Engineering, Wooster
T. J. Logan, Professor, Natural Resources, Columbus
F. V. Muir, Professor, Animal Sciences, Wooster
L. V. Madden, Professor, Plant Pathology, Wooster
K. M. Mancl, Assoc. Professor, Agricultural and Biological Engineering, Columbus
D. Southgate, Assoc. Professor, Agricultural Economics, Columbus
S. J. Traina, Assoc. Professor, Natural Resources, Columbus
O. H. Tuovinen, Professor, Microbiology, Columbus
M. E. Watson, Head of Research Extension Analytical Laboratory, Wooster

Organizational Structure of the Program

General oversight of the Solid Waste Technology Program is provided by a Program Leader appointed annually through mutual agreement by the Director of the OARDC and the Director of the Ohio State University Extension Service. The Program Leader plans and coordinates activities with an Advisory Committee and an Industry/Government Advisory Board (IGAB). The Advisory Committee consists of the Program Leader and six SWTP faculty members elected annually from the Program faculty.

The Program Leader works with the faculty in the Program, the Advisory Committee and the IGAB to identify key waste management needs, establish and pursue both long-range and short-term goals and missions. Development and implementation of appropriate policies for waste management often is frustrated by opposition and disagreement among numerous stakeholders in Society. The SWTP plans to work with all concerned to improve this situation.

Expertise of Faculty

Harry A. J. Hoitink, Program Leader and Professor, Plant Pathology and Graduate Program in Environmental Science.

Dr. Harry A. J. Hoitink's program since 1972, has concentrated on the development of optimum process parameters for composting of wastes and on mechanisms of biological control of diseases caused by soilborne plant pathogens in compost-amended substrates. His students have determined the fate of fungal and bacterial biocontrol agents in the composting and curing processes. His group has identified microorganisms, that when added to composts after peak heating, suppress or eradicate plant pathogens. Present research focuses on 1) organic matter transformations in composts that sustain the activity of biocontrol agents and 2) composting procedures that enhance activity of this microflora. He serves on state, national and international committees and boards overseeing research and education in the field of waste treatment through composting.

Jeffrey J. Chalmers, Associate Professor, Chemical Engineering

Dr. Chalmers' research emphasizes the application of principles in chemical and biochemical engineering to the activity of microbiota in biofilms. He models mass and energy balances and microbial kinetics utilizing non-destructive direct spectroscopy (DRIFT, FT-IR) to quantify rates of changes in substrates availability during composting. His group also studies the fates of biodegradable plastic films and pesticides during composting.

Warren A. Dick, Professor, Natural Resources

Dr. W. A. Dick's activities include the cycling of organic nutrients during the composting process and the kinetics of enzymes involved in the destruction of plant pathogens during utilization of composts. Other research activities include the study of potential uses of flu gas desulfurization wastes generated by the electrical power generating industries, reclamation of drastically disturbed lands, surface and ground water quality (nitrates and pesticides) as affected by no-tillage crop production, soil biochemical and microbiological activities involved in the degradation of soil-applied pesticides and xenobiotics, and the cycling of essential plant nutrients in the soil environment.

Joe E. Heimlich, Assistant Professor, Community Development

Dr. Heimlich coordinates solid waste management education programs for The Ohio State University Extension Service. He develops public education materials for schools, community groups, and businesses; conducts training programs for county, district, and state Extension personnel throughout the U.S.; serves on state, regional, and national task forces related to solid waste management education; and generates teaching materials for multiple audiences.

Jay W. Johnson, Professor, Natural Resources

Dr. Johnson's expertise is in soil fertility and plant nutrition. He is responsible for reviewing nutrient management information and developing soil fertility and crop nutrition recommendations for agronomic crops in the State of Ohio. His program addresses mineral as well as organic materials releasing plant nutrients into the soil environment.

Harold M. Keener, Associate Professor, Agricultural and Biological Engineering

Dr. Keener directs research on the composting process. He is a systems analyst, with specialization in heat and mass balances occurring during drying and/or conversion (combustion or bio) of feedstocks to end products. His role, through cooperative efforts with scientists and engineers, is the development of instrumented, feedback controlled, composting technology. Dr. Keener also provides leadership in the development of 1) computer software for analysis and interpretation of laboratory data, and 2) analytical and simulation models of energy and mass flows to optimize design and management of composting facilities. Past achievements of Dr. Keener include co-development of dynamic simulation models in the fields of bovine animal energy metabolism, deep bed grain drying, solar air-heater collectors, and fluidized bed combustion. He serves on state and national committees that oversee activities in the field of waste treatment through composting.

T. J. Logan, Professor, Natural Resources

Dr. Logan's area of research is in two areas: organic waste management and soil contamination. Dr. Logan has evaluated the beneficial use of treated sewage sludge, papermill sludge, and composted yard waste and solid waste. A focus of this work has been biogeochemistry of organic waste trace elements applied to soil. His work on soil contamination has primarily involved the in situ immobilization of trace metals in soil by phosphate addition. He and colleagues recently were awarded a patent for this technology.

Forest V. Muir, Professor, Animal Sciences

Dr. Muir's primary research and outreach interest is the management of layers and broilers including nutrient production and utilization. Other activities include the influence of ventilation on the condition of broiler litter and manure produced by layers in high rise poultry houses. He has conducted research on the burning of broiler litter as a fuel source for heating of poultry houses. He is currently involved in educational programs with the poultry industry concerning composting of poultry mortality.

Laurence V. Madden, Professor, Plant Pathology

Dr. Madden conducts research on the quantitative epidemiology of plant diseases and statistical ecology of microorganisms. His research focuses on the analysis, modeling, and prediction of

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disease increase in time and spread in space. Additional work concerns the assessment of crop losses caused by plant diseases and the multivariate analyses of microbial communities in compost. His research involves several plant pathogens, with particular attention to the elucidation of environmental and biotic factors that influence disease development. Mathematical models and statistical techniques are used for describing epidemics and quantifying the interactions between host, environment, pathogens, and microbial competitors.

Karen M. Mancl, Associate Professor, Department of Agricultural and Biological Engineering

Dr. Mancl's research focuses on the performance of intermittent sand filters for waste water treatment at low temperatures and the development of low-maintenance treatment systems for high in grease waste waters. She is responsible for adult education in the areas of water quality for homes and farms, management of manures, sludges and septate, and low-level radioactive wastes.

Douglas Southgate, Associate Professor, Agricultural Economics.

Dr. Southgate as a natural resource economist performs economic analyses of innovative technologies used in recycling and disposal of waste products. He addresses impacts of deregulation of solid waste management and studies provisions for closure and post-closure costs of landfills and of other waste treatment systems. He is an internationally recognized expert on environmental problems in Latin America and the Caribbean.

Samuel J. Traina, Associate Professor, Natural Resources

Dr. Traina's research focuses on thermodynamic, kinetic, and spectroscopic investigations on surface and complexation chemistry in soils and sediments. Specifically, he examines 1) interactions of organic contaminants with dissolved and solid soil organic matter and mineral surfaces, 2) the interactions of surfactants with soil organic matter, and 3) transformations of soil organic matter under specific management systems. He also performs research on effects of sorption on biodegradation of xenobiotic compounds, the geochemistry of lead in landfill environments, the geochemistry of stack scrubber wastes from coal-fired power plants, and the charge properties and surface acidity of clay minerals in soil.

Olli H. Tuovinen, Professor, Microbiology

Dr. Tuovinen's research emphasizes microbiological degradation of pesticides in industrial waste streams and soil and sediment environments. Some of the pesticides (e.g., mecoprop) are degraded only by microbial consortia. Therefore, considerable emphasis is placed on mass balances, degradation kinetics, environmental factors, and the evaluation of degradation potential in mixed cultures, including compost microbiota. Another research thrust is related

to mineral biotechnology with emphasis on 1) genetics of iron- and sulfate-oxidizing thiobacilli and 2) kinetic models for biological leaching processes.

M. E. Watson, Associate Professor and Head, Research Extension and Analytical Laboratory

Dr. Watson's primary responsibility is to direct chemical analysis of soil, soilless mixes, plant tissues, water, compost, animal feeds and wastes, and sewage sludges. He coordinates the development of national standards for analytical procedures for these assays. He also collaborates with faculty in the development of new procedures for analysis of soils, composts, and tissues. Dr. Watson is active in several scientific societies and serves on the Board of Directors of the National Council for Agricultural Science and Technology (CAST).