SUMMARY and RESULTS

- ORGANISATION

  ✓ Date, Venue and Host:

  September 15th,16th,17th 2004.

  Auditorio Municipal de León, León (Spain).

  Instituto de los Recursos Naturales – IRENA Universidad de León

  ✓ Institutional support from

  DG Environment, European Commision

  Spanish Ministry of the Environment.- DG Calidad y Eval. Ambiental

  Junta de Castilla y León.- Consejería de Medio Ambiente

  Ayuntamiento de León

  Diputación provincial de León

  ✓ Honor Committee

  The Excmo Sr. **Don José Luis Rodríguez Zapatero** (President of the Spanish Government) and **Doña Cristina Narbona Ruiz** (Spanish Minister of the Environment) accepted to head the Honor Committee

  ✓ Collaboration from

  Spanish Ministry of the Environment

  Junta de Castilla y León. Consejeria de Medio Ambiente

  Ros-Roca I+D

  Colegios de Ingenieros Agrónomos de Andalucía y Centro y Canarias

  CSIC- Centro de Ciencias Medio-ambientales

  Ohio State University

  Fundación Chicarro-Canseco

  Agricultura, revista agropecuaria

  Eurovías, consultora europea

  ✓ Participation

  132 total Attendees, with 20 Participants in Roundtables and 15 Speakers from 13 countries

- <u>INSTITUTIONAL INTERVENTIONS</u>
  - ✓ Welcome and opening of Pre-Conference Seminar
    Angel Penas Merino (Rector de la Universidad de León)
  - ✓ **1 Pre-Conference Seminar and Official opening of the Conference**
    Humildad Rodríguez (Ayuntamiento de León),
    Francisco Castañón (Vicepresidente de la Diputación de León),
    Manuel Alvarez Jiménez (Delegado Territorial - Junta Castilla y León),
    Jaime Alejandre (Director General de Calidad y Evaluación Ambiental del Ministerio de Medio Ambiente),
  - ✓ **Conference closing**
    José Antonio Ruiz Díaz (Director General de Calidad Ambiental. Consejería de Medio Ambiente de la Junta de Castilla y León)

- <u>TECHNICAL PROGRAM</u>
  - ✓ **1 Pre-Conference Seminar on *Research and Scientific Aspects*** with 5 Speakers and 1 Roundtable with 7 participants
  - ✓ **1 Technical Session on *Legislative and General Aspects*** with 4 presentations
  - ✓ **1 Technical Session on *Soil Eco-Biology*** with 2 speakers and 1 Roundtable with 7 participants
  - ✓ **1 Technical Session on *Compost Eco-Biology*** with 4 Speakers and 1 Roundtable with 8 participants
  - ✓ **50 Posters**

- <u>SUMMARY OF TECHNICAL PROGRAM</u>

KYOTO, MONTREAL AND BIODIVERSITY AND OTHER INTERNATIONAL´ CONVENTIONS AND ITS CONNECTION WITH SOIL AND COMPOST

Enzo Favoino (Scuola Agraria del Parco di Monza), Italy mentioned the importance to seek for the integration of policies related to waste, soil and climate change. He criticised the EU emissions trading scheme, *that only consider technological solutions and long term emission abatement improvements from the energy and industrial sector, not considering LULUCF (Lad Use, Land Use Change and Forestry) for generation of* CO_2 *credits. Should we neglect the opportunity for low cost environmental benefits from Agriculture, Biowaste, Compost as* CO_2 *sinks, in the frame of Directive EC/87/2003* CO_2 *emissions trading, to be reviewed in 2.007?.* The author concluded on *the need of recognising the potential and incorporating the new activities on forest, farmlands and biowaste management in the review of emissions trading scheme, that will take place in 2.006, implementing mechanisms more in line with science based assessment.* The author reviewed the magnitude of greenhouse gases emissions from agricultural sector, (figures taken from final report of the WG Agriculture, European Climate Change Program, 2.001) : *in 1.990 methane from agriculture was 41% of total methane emissions, and* N_2O *51% of total* N_2O *emissions*. (greenhouse effect of CH_4 is CO_2 x 21, and N_2O is CO_2 x 310), stressing the importance of *potential mitigation measures in the agricultural sector.* The author drew a scheme of potential contribution of compost and soil to tackle climate change: **Reduced use of chemical fertilisers, and related effects (displacement of alternative nutrient sources; avoided emissions from production of fertilisers; reduction of* N_2O *emissions from nitrogenous fertilisers). * Potential sink of carbon in the soil through the use of organic fertilisers (sequestration potential of agricultural soils; sequestration and build up of organic matter). * Other positive side effects of compost application (disease suppression and reduced production/application of pesticides; reduced soil erosion; reduced irrigation requirements; improved tilth and workability of soils*). Through different examples and mathematical models the speaker showed how the build up of organic matter in agricultural soils (or, similarly, preventing its decay) is an absolute priority for soil conservation and fertility, and also one of most powerful tool to prevent the climate change (*overall Italy yearly* CO_2 *emissions, 541.542 Gg, can be equalled by a lock up of just 0,14% organic carbon in soils, that are roughly 30 million hectares).* As a closing remark, the author proposed that *LULUCF (Land Use Land Use Change and Forestry)* *mitigation measures and compost use should be integrated in the EU emission trading scheme, driving farming practices towards patterns of higher sustainability, thereby renewing the environmental role of the agricultural sector and generating CO_2 credits as an extra income for farmers, rewarding them for their contribution. He also mentioned that pilot schemes for subsidies to afrmers using compost in depleted and sensitive areas are already in place in some Regions in taly, in the Frame of Rural Development Plans.*

TOWARDS AN INTEGRATED SOIL-BIOWASTE-COMPOST STRATEGY IN THE EU

Florian Amlinger (European Compost Network) Austria, summarised the EU Soil Strategy initiative, that recognises *soil erosion, decline in organic matter and contamination as the main priorities to deal with,* reviewing the works performed for the 5 working groups integrated for 300 specialists and stakeholders during 2.003 and 2.004. *Soil strategy will cover already existent legislative initiatives as Directives on Mining Waste, Sewage sludge and Biological treatment of biowaste as well as new ones like Soil Monitoring Directive.* These works should rend a *"Strategic Framework Document" and/or a "Soil Framework Directive". The new "Agriculture and Soil unit" within the DG Environment would develop a proposal for the soil package by the end of 2.004.* The author resumed the main conclusions of the Working Group "Organic Matter", Task group "Exogenous organic matter-EOM": * *Recommendation of the application of exogenous organic matter if it is of an appropriated quality and if it is applied according to good practices., * Contribution of the EOM to limit the decline of soil organic matter and assist with reducing soil erosion, enhancing biological activity with better aggregation and porosity of soils, tilt and workability, buffer capacity, reduce nutrient leaching, improve water retention, etc, * Applying composted EOM it is an effective way to divert carbon dioxide from the atmosphere and convert it to organic carbon in soils, combating the greenhouse gas effect.* In line with the communications of the EuroParliament and the EU Council, *the working groups Organic Matter and Contamination recommend clearly to establish regulatory drivers for source separation and composting of organic waste. Source separation of organic household waste has definitely been proven as the method to provide and maintain a quality level of compost which does not endanger soil functions if the compost is applied according to good agricultural practice.* As conclusions, the author proposed that *the strong link of the initiative for the new Biowaste Directive with the EU Soil strategy is a reasonable step towards a sustainable organic resources management. Most important tools are: * Setting targets for m.s.w. source separation as flexible frame for Member States*, ** Minimum quality standards system for compost , leaving enough flexibility for Member States in order to set individual requirements for the use of sludge and biowaste according to local* *soil protection needs*, * *Establishing a quality assurance and monitoring systems as an integrated element of the process.*

Ines Vogel (German EPA) **Germany**, presented the German legal soil framework composed of Federal Soil Protection Act (1.999) and Contaminated Sites Ordinance (1.999), introducing *the scope of the soil protection law: to maintain soil functions in a sustainable way or to restore them*. Consequently *precaution must be taken to avoid the occurrence of harmful changes to the soil, also concerning the discharge of harmful substances into soil by cultivation activities, especially fertilizing.* The author reviewed the main sections of Soil Protection Act: * *Principles and obligations (prevent hazards, unsealing of sealed ground, application and introduction of materials on or into the soil, obligation to take precautions, values and requirements and risk assessment and order for studies), * Supplementary Provisions for Contaminated Sites, *Good Agricultural Practices and * Final Provisions.* Essential criteria for precautionary soil protection were also analysed: * *Preserve the natural soil functions, as habitat for plants and soil organisms, as regulatory body in ecosystems and the functions as the site to be used by agriculture and forestry, * Preserve the abiotic factors e.g. the structures of clay minerals with their significance for natural soil functions as well as the soil structure, * Preserve the integrity of soil as a part of the ecosystem, * Protection of groundwater as an indirect result of soil protection, * Protect the public health, in particular avoid the direct uptake of soil caused contamination of fodder and foodstuffs including ground and drinking water, * Preserve the soil as a scarce resource, e.g. against soil loss by erosion, sealing and denaturation* . The waste to soil activities are controlled in Germany by the Federal Recycling Management and Waste Act (1.994), Sludge Ordinance (1.992) and Biowaste Ordinance (1.998), *setting provisions that matches with the values outlined in the soil regulations, including as focal points: requirements to ensure human, animal and plant health, requirements concerning pollutants, requirements concerning application in agriculture and obligations to provide proof.* For the future the outlines are settled of the "German Fertilizer Concept", *a framework of rules and regulations that provides an unified assessment for all substantial discharges on soil, with the aim of restrict unavoidable input of pollutants to an equilibrium between input and tolerable output or to restrain pollutant concentrations in discharged materials to tolerable loads for soil. The main aspects of this concept are: * the long-term residual fraction of materials in the soil (mineral and organic);* the nutrient contents of organic fertilizers; * the nutrient demand of plants; * the withdrawal of heavy metals by plants and * the analytic variation limit. For this purpose, a stronger harmonisation of the requirements for the quality of all fertilisers can be a first step.*

SOIL AND COMPOST BIODIVERSITY

Anton M. Breure (RIVM-National institute for Public Health and the Environment) The Netherlands, indicated that *a proper soil functioning now and in the future is a key life support element. Keywords in this respect are "sustainable development" and "sustainable use of biodiversity" (UNCED 1992). A general European Soil policy is to be launched because of its nature as a non renewable resource, and of its functions that have to be used in a sustainable way. Ecological functions and soil biodiversity are important because of their role in: structure formation, stability of structure and functions, fertility, buffering and in providing possibilities to have the soil acting as a carbon sink (UNFCC). Soil biodiversity can be identified as a major component of soil. Governmental concern is growing how to attain sustainable use of soils, e.g. its agricultural use. There is increasing consensus, that protection of the biodiversity in the soil is a major way to maintain the proper functioning of the soil. In agro-ecosystems, ecological functioning of the soil can be seen as a production support function of biodiversity, next to e.g. pollination and natural pest control. Soil organisms are major component of all soils. Often their biomass is low compared to the mineral or humus fraction, but the organism activity is absolutely crucial for a functioning soil. The soil biota can be regarded as the "biological engine of the earth", and is implicated in most of key functions soil provides: nutrient cycling, soil structural dynamics, degradation of pollutants, and regulation of plant communities. Microbially driven soil processes play key roles in mediating global climate change, by acting as C sources and sinks and by generation of greenhouse gases such as nitrogen oxides and methane.* The author presented the definition of Biodiversity made by the Convention on Biological Diversity (CBD) as *"The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species (genetic), between species (richness), distribution of individuals among those species (evenness) and of ecosystems".* Regarding the functional diversity, (role of species and groups of species in the ecosystems), *Biodiversity "sensu lato" may be regarded as the ecological capital in the soil.* A review was made of soil biodiversity: *macro-, meso-, micro-fauna and microorganisms (bacteria, fungi, protozoa and algae). The biological components occupied a tiny fraction (>0.5%) of the total soil volume, (<10%) and of soil organic matter. Earthworms often form a major part of the soil fauna biomass (up 50 to 60%).* The author analysed how the human practices (e.g. in agricultural ecosystems) can threaten soil biodiversity: *reduction of soil macrofauna is one of the most profound ecological consequences of modern agriculture, as an example, the number of earthworm species is largely decreased in agricultural soils. The biodiversity of the soil organisms lead to the control (natural biological suppression) of plant root diseases. The management practices used in many agro-ecosystems (e.g. monocultures,*

extensive use of tillage, chemical inputs) degrade the fragile web of community interactions between pests and their natural enemies and lead to increased pest and disease problems. Decline in soil biodiversity is expected to affect soil turnover, decrease natural soil aggregation, increase crusting, reduce infiltration rates, and thus exacerbate soil erosion.
The main driving forces that influence soil biodiversity in agricultural soils are:
** Intensification in land use (destruction of habitats, trees and shrubs, compaction)*
** Crops, crop residuals and added organic matter (developing specific microbial communities).*
** Plants (symbiosis with plants at rhizosphere area; crops rotation).*
** Fertilisers & pH (diverse fungi and bacterial population, decrease of earthworms at low pH)*
** Tillage (destruction of stratified microhabitat, decrease biodiversity, nutrient mineralization)*
** Pesticides application (destruction and uncontrolled shift of soil biota)*
** Pollution (toxicity, mutagenic effects and stress to the soil biota and plant communities)*
Determination of soil biodiversity can be made by measuring *"species diversity and quantity"* and through biochemic*al measurement of "soil biological activity"* or through *"ecosystems and food web models"*. The author reviewed the different biodiversity indicators and its required characteristics for each specific monitoring program, the monitoring activities in different countries and the two suggested types of monitoring programs: ** Level 1, for trends observation in large areas, in grids e.g. 16x16 km. * Level 2, thematic or specific soil sites, management practices or impacts intensively monitored.* A general proposal for soil biodiversity monitoring was made by the author, including *bacteria and fungi (the highest amount of ecological capital is in the form of microbial biomass), nematodes (high species diversity, representatives of each ecosystem and its status, easy to handle) and earthworms (high numbers, easy to count, with many scientific and practical implications).* The author suggested that for proper management of monitoring programs, many considerations should be taken into account as *status and trends information obtained from data, connection with abiotic and other parameters to be monitored, the need for the development of standards to compare with data, the development of knowledge for influencing the observed trends (e.g. changes in land management or land use)*
As concluding remarks, the author underlined: ** By protection of soil biodiversity the functioning of the soil can be secured. * Diversity, abundance and activity of soil organisms indicate the degree of sustainability of soil management. * Living organisms are reliable indicators of environmental quality, providing the best reflection of the actual fitness of their habitat and ecological changes therein. * The recognition of the importance of soil biodiversity has taken place and the direction of the developments in protection of biodiversity and its application of soil monitoring and in man-used ecological services is promising.*

SOIL CONSERVATION AND QUALITY

***Godert van Lynden (ISRIC-International Soil Reference and Information Centre), Netherlands**,* performed an historical review of global land maps, *that are pivotal to the "UN Convention to Combat Desertification"*, *the Convention on Biodiversity and the Kyoto Protocol on Global Climatic Change,* stressing the need for global scale soil information, still not available (*only the FAO-UNESCO World´s Soil Types Map at a scale 1:5M, 1971-1978) that is being gradually replaced by maps based on the SOTER (Soil and Terrain Digital Database) methodology. FAO, ISRIC and UNEP partnership agreed in 1.995 to work towards a common world SOTER –shell approach covering the globe at 1:5M scale, in progress but still far from its fulfilment. The SOTER program provides an orderly arrangement of natural resources in such a way that these data can be readily assessed, combined and analyzed from the point of view of potential use and production (food requirements, environmental impact and conservation).* As existent models are static inventories of soil situation, a need for dynamics of soil degradation analysis was detected. *GLASOD (Global Assessment of Human-Induced Soil Degradation), was a 1.990 ISRIC-UNEP initiative, that resulted in a global map of soil degradation, achieved in 3 years, at 1:5M scale, later digitized. Four major degradation types were distinguished by different colours in the map, of which two types (water and wind erosion) were characterised by displacement of the materials and other two (chemical and physical degradation) by processes in situ. The extent and degree (seriousness) of the degradation process was combined into a "severity" factor which determined the brightness of the colours.* The author presented one table, showing that the main degradation factors by the decreasing order of magnitude that are, *"Loss of topsoil due to water and wind erosion, followed by chemical (loss of nutrients, salinization, pollution and acidification) and physical degradation (compaction, waterlogging and subsidence of organic soils),* resulting near 60% of world soils are moderate to strongly affected by degradation processes. *GLASOD results based on experts assessment, successfully managed to draw attention to the problem, but still do not form a basis for comparison of changes in soil and land quality over time. Other* on-going activities reviewed were:

** LADA (Land Degradation Assessment for Dryland Areas Project), aims to develop and test effective methodology to assess causes, status and impact of land degradation in drylands in order to improve decision making for sustainable development in dryland at local, national sub-regional and global levels. * GLADA. Biomass is an integrated of biological productivity; its deviation from the local norm is a measure of land degradation. * Spectral response to soil quality. * WOCAT (World Overview of Conservation Approaches and Technologies). It is a documenting and evaluating soil and water conservation case studies worldwide*.

** SOWAP / Pro Terra. Both projects aim to assess the viability of a more "conservation-oriented" agriculture. * EU Thematic Strategy for Soils, response to concerns about the conservation of soil in the EU. * PESERA (Plan European Soil Erosion Risk Assessment).*
As concluding remarks the author highlighted the importance of the soil sealing (urbanisation related activities) and water erosion by far the two main worldwide causes of soil degradation. He also arose the question or proposal on how to integrate the efforts of international groups working on *land degradation* with those related to *land soil improvement* (organic matter, biology and ecology in soils, agro-ecology), *maybe through a crossed participation in international teams and projects.*

COMPOST QUALITY

Jacques Fuchs (FiBL-The Research Institute of Organic Agriculture), Switzerland, introduced the quality of compost approach, when *compost is produced in order to improve fertility of the soil and growth of the plants, and not for waste management as a principal goal. Oxygen supply seems to be the most important factor affecting compost (biological) quality. Maturation and conditions of storage (keep a good oxygen diffusion is advisable) are also important factors affecting compost quality. Loss of suppressive effect of compost after heat treatment indicates that disease suppression might be linked with the microbiological activity. Antagonists developed during maturation can reduce the incidence of various compost diseases. While almost all compost tested protect cucumber plants against "Phytium ultimum", only some of them have the capacity to protect basilica against "Rhizoctonia solani". So a general protection mechanism is assumed for "Phytium ultimum" and a specific mechanism in the case of "Rhizoctonia solani". Industrially used peat substrates are microbiologically inactive, therefore a very small quantity of pathogen inoculum is sufficient to get a high disease incidence. In these cases adding quality compost can efficiently protect plants. (So it does quality compost added in soil steamed soils). Improvement of soil fertility in the field with quality compost have been proved in 5 year (10 ton $^{y-1}$) experiment, showing reduced incidence of "Phytium ultimum" and "Rhizoctonia solani" in compost treated plots. Quality compost effects are not restricted to suppression of soilborne diseases, they also reduce development of foliar pathogens as Erisiphe ("Blumeria graminis so hordei") by inducing disease resistance in barley plants.* The author concluded that *our knowledge is enough to allow the production of good quality compost. The three mos important factors are the moisture* *of the materials, the air composition and temperature. At the end of maturation pH, salt content, ammonium nitrite and nitrate content have to be analysed. Plant tests and disease suppressive properties against "Rhizoctonia" and "Phytium" are also recommended. With this information, it is possible to choose the most appropriate compost for each utilisation. ASCP Guideliness 2001 "Quality criteria for compost and digestates from biodegradable waste management" published by the Association of Swiss Compost Plants, provides support for compost producers and users with this respect.* As conclusion the author mentioned that * *phytopatological problems could be solved with the use of compost;* * *the interesting perspectives of quality compost for growers are: Introducing and establishing a beneficial soil microflora, prevention and degradation of toxic compounds, microbiological buffering and disease suppression.*

Rosa María Fernández (aqualia), Spain performed a review of "pathogens" presents in different organic residuals and substrates, "biological test microorganisms and indicators" in legislation from many countries, including a scientific analysis of its adequacy and also listed the main treatment technologies (composting, lime stabilisation, thermal treatments...) with its main pathogen controlling factors. The author indicated that *very little effort has been dedicated to study the "positive biology" in organic substrates, compost and fertilisers and their subsequent positive effects on soil and crops. So biology and ecology and in general "life in compost" are sistematically forgotten or neglected. Some questions then still remain unformulated today from eco-biological standpoint: * Are the sanitary indicators adequate from scientific perspective?, * Are these indicators a measure of biological quality of compost?, * Are the extreme temperatures or pH processes necessary and safer?, * Are there other sanitization methods by biological dynamics enhancement?, * What is the right compost quality for specific uses, soils and crops?.* The author demostrated how *legislation is only patly founded on scientific evidence,* e.g. the use *Clostridium perfringens*, Enterobacteria, *Escherichia coli, as indicators, being widespread in the environment (soil and water and even in raw vegetables), seems questionable.* Regarding the *extreme conditions applied for pathogen control,* the author underlined that *they can not selectively operate on pathogens, so the positive biology in substrates and compost is seriously affected. As compost and related products could be defined as "living mediums or soil like ecosystems" with an incredible biological diversity and complexity, we could imagine that a management of this spontaneous biology is possible, including biologically driven pathogen reduction and inactivation compatible with a "high biological quality of compost".* The author analysed the current *biological quality of compost developments as: * Biochemical indexes or * Biological indexes (Total heterotrophic microorganisms, Total microbial biomass, N microbial biomass, Total bacterial biomass, Total* *fungal biomass,C microbial biomass, Nematodes –species-, Protozoa, Micro and mesofauna, Macrofauna –lumbricids.-). The interpretation of these parameters would require an ecological assessment, also considering the balance and ratios between different groups and species presents in compost to produce a report identifying "biological quality of compost". The analysis should be complemented with the information of soil characteristics and legay, farming practices and crops, so the right compost could be used for the right situation and soil-crop binomial.* The author set up that agro-ecosystems and agroecology could be the common frame for the agro-ecological analysis of organic substrates, compots, soil (and crops), with many advantages *from cultural standpoint, protection the biodiversity of soil and the environment and enhancing the quality of the crops and food products.*

MOLECULAR TOOLS FOR SOIL AND COMPOST ANALYSIS

Antonio Morán (Institute of the Natural Resources-University of León) Spain*,* reviewed the state of the art of research on microbial ecology in soil and compost starting with the evolution of the techniques used to measure the biological activity in soils, through fenotypic or genotypic based methods. *From traditional "plate counts" to biochemical indexes (soil respiration), determination of microbial biomass, enzymatic activities, substrate utilisation profiles, (Biolog ^{TM}), or PLFA (phospholipids fatty acids analysis).* The author introduced the new molecular methods, developed due to thorough limitation and non-specific character of traditional count or bio-chemical systems: ** PCR (Polymerase chain reaction), * RFLP (Restriction fragment length polimorphism or * ARDRA (Amplified ribosomal DNA restriction analysis)*, recently developed but with *promising possibilities for the quick detection, identification and characterisation of microbial populations in complex media like soil and compost.* Regarding the future development and the need for techniques improvement, the author stressed the need for a better definition scientifically based of *"microbial specie" and "soil biodiversity , the identification of functional genome and DNA from living individuals for a proper assessment of the functional or metabolically active population.* He also show up the need for applied research of biodiversity and soil ecology with agriculture and the environment, * *relationship between structural and functional diversity, * biodiversity and soil fertility, * soil quality indexes, * impact of natural and anthropic factors (as salinity, compaction, drought, acidification…) on soil biodiversity, * impact of farming and forestry practices, compost and agri-chemicals application, **

*research on diversity of AMF (arbuscular mycorrhizal fungi) associated to roots and * impact of GMOs (genetically modified organisms) on soil biodiversity.*

Janice Thies (Cornell University) USA, indicated that *molecular tools offer unparalleled opportunities to characterise bacteria in culture and directly from field or soil or compost. We are now able to examine such issues as how microbial populations vary across soil types and climatic zones, in association and between various plant species, and in response to soil management or soil pollution.* The author analysed the difference between the traditional culturing and the molecular techniques: *It is well known that traditional culturing methods detect only a small fraction of the existent microbial diversity in soil. Molecular techniques employing bulk soil DNA extraction and cloning with or without polymerase chain reaction (PCR) amplification with "universal" primers for rRNA genes often reveal the presence of populations that are not recovered by traditional culturing. However, populations detected by molecular methods such as clone libraries and DNA fingerprinting, may still not correspond to populations responsible for significant biogeochemical processes in situ, especially when these populations constitute less than 1% of the total community*. She said that application of molecular methods must be based on the recognition that soil organisms are physiologically and phylogenetically diverse. The author introduced different molecular methods:
** phospholipid fatty acids (PLFA), * nucleic acid approaches, * extraction of nucleic acids (DNA/RNA),* direct analysis of nucleic acid extracts: ** DNA:DNA re-association kinetics, * nucleic acid hybridization, * microarrays, * restriction fragment length polymorphism (RFLP) analysis, * cloning and partial community analyses – polymerase chain reaction-based assays, * polymerase chain reaction (PCR). In any study where PCR will be employed, sources of bias must be considered. The main sources of bias in amplification of soil community DNA are: * use of very small sample size (typically 500 mg of soil) which may represent only a small fraction of the whole soil community, * electrophoresis of nucleic acids, * denaturing or temperature gradient gel electrophoresis (DGGE/TGG), * terminal restriction fragment length polymorphism (T-RFLP) analysis, T-RFLP analysis exploits rapid community DNA extraction methods, PCR, RFLP, the resolution of polyacrylamide gels and automated sequencing technology, and 16S rRNA gene sequence database information to determine key bacterial groups present in environmental samples, * terminal restriction*

*fragments (TRF) are sized and comparisons between samples made by use of similarity matrices and clustering analysis. * Stable isotope probing (SIP), * DNA sequencing, * Software for similarity analyses, * biosensors and marker gene technologies.* The author concluded that *modern molecular techniques developed to study of microbial populations, such as T-RFLP, and DGGE, allow access to the very large proportion of organisms that are present in the soil and which remain unculturable under laboratory conditions. Other techniques, such as metabolic fingerprinting and RFLP analysis of radio-labeled amplified nifH, amoA, nirS, and pmoA sequences will allow us to target, with high specificity, organisms or groups of organisms at different taxonomic levels. These should prove to be useful detection tools in ecological studies, allowing a far more complete and less biased view of bacterial diversity in soil and compost.*

BIOLOGICAL CYCLING OF NUTRIENTS AND AGRI-CHEMICALS REDUCTION

Jacques Fuchs (FiBL-The Research Institute of Organic Agriculture), Switzerland presented the DOK long-term field experiment, started in 1978 at Therwil, close to Basel, *comparing the farming systems bio-(D)ynamic, bio-(O)rganic and (K)Conventional. Feasibility of organic farming was investigated during the first years, crop yields measured, effects on long term soil fertility and the environment were rated and finally. Today the quality of organic products is the main research interest. The DOK trial compares the three systems on the basis of the same intensity of organic fertilisation, the same crop rotation and the same soil tillage. Fertilisation and plant protection are different according to each farming system. Crop yields of the organic systems averaged at 80% of the conventional one. The fertiliser input was 34-51% lower, indicated an efficient production, using 20-56% less energy per crop unit an per land area this difference was 36-53%. The quality of organic product was hardly discernible from analytical or appearance standpoint and even came off better in food preference. The organically treated plots were biologically more active (40 t/ha of microbial biomass) than conventional (24 t/ha), whereas chemical and physical soil parameters differed less significantly.* So as mode of conclusion the author stated that *the organic farming systems show an efficient utilisation of natural resources and present a higher floral and faunal diversity, being a realistic alternative to conventional agricultural systems.*

COMPOST AND COMPOST TEA FOR CROP´S NATURAL DISEASE SUPPRESSION

Isabel Trillas (Universidad de Barcelona) España, presented an experience on pot cultivation of tomatoes and cucumber, filled with different compost produced with municipal solid wastes wine and oil residues, rice hulls, cork and peat, and different combinations of them, *reporting the suppressive action of composts against two important plant pathogens (Fusarium oxysporum, and Rhizoctonia solani). The author also described the benefits of Trichoderma asperellum, biocontrol strain T-34 isolated and developed from composts from urban residues, being able to consistently reduce diseases produced by F. oxysporum and R. solani when added to the developed composts and peat substrates. Also worth noting is the great suppressive capacity of grape marc compost, due both to the (natural) action of the micro-organisms and to its chemical properties (0 and 3%of affected stem). Natural cork compost (17 and 35% of affected stem), suppressive capacity is due exclusively to the micro-organisms. Natural peat (low in biological activity) has values like those of cork compost with microbiological vacuum and the disease results are significantly higher than they are with natural composts.* So high microbiological activity in compost from residuals, is a main mechanism to reduce pathogen grow and to produce disease suppression. Long maturation or enrichment with specific biological control agents, like *Trichoderma asperellum* T-34 (that consistently reduces diseases produced by *F. oxysporum* and *R. solani*). *Spain is one of the largest areas in Europe where horticultural crops and flowers are intensively cropped in plastic greenhouses, in fields or in containers. The practice of disinfecting soil with methyl bromide or other chemicals is extremely widespread. However, as a member of the EU, Spain is required to reduce these practices in the short term. Plants growing in composts will need less pesticides, with all the accompanying advantages, not only for the producer's pocket, but also for the safety of the sprayer, the consumer and the environment.*

Dr. Harry Hoitink (Ohio State University) USA*, reviewed the recent history and the present state of knowledge on control of plant diseases with composts* and also *potential future opportunities for control of plant diseases with inoculants of specific biocontrol agents (focus on utilization of composts in container media). Composts have been used for centuries to maintain soil fertility and plant health. Even so, the mechanisms by which diseases are controlled by composts are just now being elucidated.* The author explained the evolution of the knowledge in this field through different milestones: * *Suppression of root diseases with composts has been most successful in container-produced plants*, * *Early during the development of container media, it was learned that peat mixes generally did not suppress Pythium or Phytophthora root rots*, * *High quality peat was not available at low cost in all locations, therefore, the nursery industry began to develop alternatives to peat, * Procedures were developed for production of nursery crops in composted bark and sawdust-amended media that also supported predictable control of plant parasitic nematodes and of Phytophthora and Pythium root rots, * Composts do not naturally suppress foliar diseases, based on observations at growers, the suppressive effect supplied by composts seems to be limited to diseases of roots.* The author also described the most relevant compost quality factors: * *The decomposition level of the organic fraction in composts (maturity/stability) critically affects biological control. Composts must be stabilized to reach a stability level of at least 1.0 mg CO_2-C g^{-1} dw d^{-1}*, * *Compost produced with temperatures exceeding 70^oC for long periods of time, does not support the activity of biocontrol agents. * Salinity is another property of composts that must be considered in compost quality control.* The main advantages with compost use in nursery (containers production) were highlighted: * *peat substitution, * reduced pesticide use, and * macro and micro nutrients slow release supply (e.g. compost from manure, residuals).* Dr. Hoitink analyzed several experiences on compost-induced systemic resistance (ISR) with active biocontrol agents (as T-382, *Trichoderma hamatum* 382 (T382) finding that *that suppression of foliar diseases with natural composts is a rare phenomenon and that growers cannot rely on this approach to disease control. It also may explain why compost-induced foliar disease control was not discovered by growers under commercial conditions.* So biocontrol agents *must be inoculated into composts for consistent efficacy.* Finally the author presented one *novel method for production of plants known as the "pot-in-pot system" allows trees to be produced in containers buried in soil. Another development is incorporation of massive doses of composts and green manures between nursery crops into field soil on a 3-5 year production plan basis. This system is designed to mimic placement of a forest litter horizon on nursery land.*

RESEARCH IN ORGANIC FARMING RELATED TO COMPOST

Victor Gonzálvez (IFOAM EU- SEAE group) Spain, presented an historical and peer review approach to *the state of research and experiment in organic farming, with special reference to composting, the use of compost and soil eco-biology in organic farming. After some pioneer efforts started in the early decades of XXth century, it was in the '80's that the idea of Organic Farming earned acceptance in some Central European universities, although small research centres had devoted limited efforts to the subject, especially in the field of biodynamic agriculture, ever since the '50's. In 1997 Spain allocated less than 5% of the figure set aside by Germany, less than 2% of that set aside by Sweden and less than 1% of that earmarked by Denmark for organic farming research. It is only in the last 5 years that European Union (EU) funds, national funds or regional funds have been set aside for research in organic farming.. A number of specialized reviews and organizations like Sendero, Vida Sana and, in particular, the best known of them, Revista Integral, started to promote and disseminate the achievements and benefits of organic farming in Spain at the end of the '70's, even publishing the first books to come out on organic farming and composting here. It was not until 1983 that the first official scientific reference to biological or organic farming appeared in a review published by the Ministry of Agriculture and Fisheries. The prologue said it wanted to draw the attention of the sector's leaders to the undeniable contradictions inherent in the large-scale industrialization of agriculture. The review presented a few papers by Spanish naturalists and researchers which had, in isolation, taken up the subject from viewpoints very similar to those of organic farming. The ideas and ideals of the organic farmer were thus finally aired. The participation of the International Federation of Organic Agricultural Movements (IFOAM) in the European Scientific Congress on Biological Agriculture at a venue provided by the Higher Council of Scientific Research in Madrid (CSIC), in 1.985, converted the event into an explicit recognition of this approach to agriculture by certain "official" scientific circles. The Spanish Organic Farming Association (SEAE) has provided the principal forums for exchange and dissemination of organic farming research. Over 450 research papers have been presented in them over the last ten years, mainly in SEAE bi-annual Congresses (IV Congress was recently held on October 2.004 in Almería). Perhaps because of the lack of a strong tradition in the use of compost in Mediterranean* *farming, there have been few studies on its application. As we shall see, most of the research carried out into composting has to do with making use of agricultural waste, like olive marc and other crop residues, but not with using it as a method to increase the biological activity of the soil.* Finally the author presented *the IFOAM-EU Group* activities and *involvement in five European projects for the certification of organic farming inputs, organic farming support policies, the revision of European organic farming legislation, the European ecological market information system and the evaluation of action plans to promote organic farming. The research priorities established by the sector are: 1) ideas for research on vegetable production; 2) ideas for research on animal production; 3) ideas for research on socio-economic aspects; 4) quality, health and food safety; 5) the environment.*

COMPOST TEA

***Steven Scheuerell (Oregon State University) USA**,* presented the definition and main aspects of *Compost tea, produced by mixing compost with water and culturing for a defined period, either actively aerating (aerated compost tea, ACT) or not (non-aerated compost tea, NCT) and with or without additives that are intended to increase microbial population densities during production indicated different production system of compost tea. An important distinction between NCT and ACT is that ACT uses compost, water, and nutrient additives to greatly increase microbial populations over a 12-36 hour period, while NCT uses greater quantities of compost, typically doesn't add separate nutrient additives, and is produced over several days to several weeks. The utility of compost tea as a plant production tool is further impacted by application parameters such as addition of spray adjuvants, and application rates and timing.* The author concentrated on three *current areas of compost tea research: the effect of compost tea production practices on the resulting microflora; the use of compost tea as a drench for controlling seedling damping-off diseases; and concerns of multiplying bacterial human pathogens in compost tea.* Regarding the resultant microflora in final compost tea the author indicated that *the materials and methods used to produce compost tea are selective forces that affect bacterial and overall microbial diversity, abundance, and evenness of microbial populations in compost tea.* Aeration and nutrients addition will radically change the microbiological profile of compost tea. As result of some health concerns in nutrient enriched ACT, *compost tea use by certified organic farms has been* *regulated under the USDA National Organic Program. No compost tea regulations exist for non-organic farms.* The author presented the hygienic key recommendations of compost tea: * *Use properly made compost, potable water, and sanitize compost tea equipment,* * *Exclude vectors of disease causing organisms,* * *If nutrient additives are used, the compost tea production system must be pre-tested to ensure that indicator bacteria do not exceed level set by EPA for recreational water quality.* The author concluded that *compost tea is not a silver bullet for solving widespread problems associated with depleted soils or unsustainable farming practices. However, produced with microbiological quality in mind, and integrated into holistically managed biological farming systems, compost tea can be used as a carrier to deliver plant nutrients and manage plant diseases.*

SOIL AND COMPOST AS ECOSYSTEMS

Matthew Slaughter (Soil Foodweb Inc) USA, introduced the food web approach mentioning that *soil foodweb consists of bacteria, fungi, including mycorrhizal fungi, protozoa, nematodes, micro arthropods and a range of aboveground predators*, presenting different methods used to assess bacterial and fungal biomass in soil and compost as * *direct microscope methods: light microscope methods, phase contrast microscopy, etc.,* * *plate methods,* * *chloroform fumigation,* * *enzyme methods*. He answered some question as, * *do we need to know the difference between bacteria and fungi?: fungal biomass is predominant in some samples, while bacteria are dominant in others. As compost, or soil, is scanned, this predominance remains throughout the whole sample, through the whole compost pile, through the whole forest, agricultural field, and so forth.* * *Is real compost made of plant matter?: when examining compost, it is also quite apparent that well-made, properly aerobic compost is comprised mostly of organisms on all surfaces.* * *Is compost really plant material, or is it bacteria, fungi, protozoa, nematodes, and micro arthropods?: certainly examination of well-made compost would leave no question in an observer's mind. However, mulch or putrid organic materials lack these organisms, and thus when adding putrid organic matter, the inoculum of the organisms will not be present, and therefore the benefits that can come from the addition of these organisms to soil cannot result.* * *Why does a pile of food materials become anaerobic?*: *when feedstocks are high in sugar, simple proteins*

*and simple carbohydrates, bacterial biomass can grow rapidly, using up oxygen and dropping oxygen to a level where facultative organisms shut down their aerobic metabolic enzymatic machinery, and activate anaerobic metabolic enzymes. * Can organisms in composts and in liquid composts (aerated compost teas) benefit plant growth?*: *plants grown in the compost pots actually had higher visual quality than the plants growth in potting mixes.* He concluded that *the compost contains mostly beneficial organisms, since any pathogenic organisms will be out-competed, suppressed and inhibited by the enormous diversity of organisms growing in compost.*
*The healthy foodweb benefits are: * Suppress disease, * Plant available nutrients, * Decompose toxins, * Build soil structure, * Reduce water use, * Increase water holding capacity, * Increase rooting depth, * Reduce erosion, but however .... We still need to better understand the changes of buildup and mineralisation dynamics in compost ammended soils in order to optimise the humus management*.

Round table September 15th, 2004

WHERE TO ADDRESS THE RESEARCH ON SOIL AND COMPOST ECO-BIOLOGY AND THE ROLE OF THE RESEARCHER

Antonio Bello (Centro de Ciencias Medioambientales [CCMA], CSIC), Spain, indicated that *the investigations about soil and organic matter and eco-biology have lost their meaning in the agricultural systems based on the use agrochemicals. Soil fumigants cause the total loss of soil biodiversity, eliminating organisms that are fundamental for the organic matter bio-decomposition.* This situation *is creating a change towards soil less agriculture or the application of steam for the control of pathogen organisms on vegetables as the only viable alternatives for the future. However these alternatives can produce a great environmental impact, and in the case of the soil less agriculture, they can also show pathogen problems similar to the conventional agriculture.* highlighted that the for *increasing the profitability of the agricultural systems, it is necessary to achieve the autonomy of the producers, by means of the use of local resources, like the case of use of organic matter that should be close to the production places, since the transportation costs are one of the main restrictive factors in agriculture.* He outlined *the importance of the closed systems in the use of the* *organic matter, so that they return to the soil those materials coming from it, so that they don't end up being a source of contamination for the next crops, but rather they increase the soil fertility and their functional biodiversity, improving physical properties of the soil.* As conclusion the author highlighted the *need of a new position in the organic matter investigation and management, and mainly on composting investigations that should make emphasis on the existent interrelations among compost-soil-crops, with a multidisciplinary view, keeping in mind the agro-ecological characteristics of the crop and specially the soil eco-biology.*

Salustiano Mato (Universidad de Vigo), Spain, highlighted that *the most important thing to be successful in the design of the composting process is a clear and right definition of the strategy to carry out. The technological configuration is secondary. In fact an inadequate election of the fundamental conditions when establishing a strategy won't never be solved with changes on the machinery, the mechanics or automation of the process. For it the clear benefits of a good and novel technological configuration are subordinated firstly and mainly to their compatibility with the application of the appropriate strategy*. The author underlined the importance *of the investigation in the field of the composting and compost, due to *the physical configuration of the composting mix "matrix"; the production of quality compost; *the influence of a series of physical and chemical factors, such as Humidity, pH, Temperature, Oxygen, Carbon Dioxide, ammonia Nitrogen, etc.* The author *indicated that if the investigations on the process, carried out first at lab or pilot scale, could define more effective and efficient ecological configurations.*

Round table September 16th, 2004,

ECOLOGY AND MICROBIOLOGY ROLE IN SOIL CONSERVATION AND FERTILITY

Carlos García Izquierdo (Centro de Edafología y Biología Aplicada del Segura [CEBAS-CSIC]), Spain, indicated that *the true importance of the micro-organisms as for their relationship with the soil quality, or with degradation processes, it is not so much to know the types of micro-organisms that carry out concrete functions, but the microbial activity in that specific media. Biochemical parameters can constitute an excellent starting point for soil eco-biological assessment.* The author highlighted that *the metabolic activity of micro-organisms is the main responsible in soil processes like mineralization or humification, which highly impacts on another series of soil processes. The metabolic activity would permit to measure problems of contamination and the performance of a further de-contamination.* He outlined *the great interest nowadays in the study of biological and biochemical parameters, as indicators of the microbial activity, directly in newly generated organic materials like composts. Studies carried out on them have shown the existence of enzymes of all type, sometimes in high quantities, then being able to denominate them as "materials with high biochemical load".* He mentioned that in the practice *soil biochemical parameters can be named and used as "bio-indicators of the soil quality and sustainability".* He concluded that *the correct interpretation of these parameters will help without a doubt, to know the reason of many of the worsening processes that are given in the soil, helping therefore to prevent them, contributing this way to improvements in soil conservation*.

Avelino García Álvarez (Centro de Ciencias Medioambientales [CCMA], CSIC), Spain, introduced the idea of *the soil as a subsystem with its own entity inside the terrestrial ecosystems, derived from the fact of receiving a net flow of energy contained in the necro-mass (organic matter) that is continuously receiving* . On the other hand, the author indicated that *the organic matter decomposition is a synergy process between the soil micro-flora and the fauna, particularly the micro and meso-fauna. In general terms it can be said that the soil fauna carries out a previous work of mechanical fragmentation, increasing the external surface of the organic materials, favouring this way the microbial attack. The soil micro-flora is the ultimate responsible for most of the organic matter oxidation processes and final mineralization.* He also indicated that *the organic matter oxidation is carried out by extra-cellular enzymes produced by bacterias, mushrooms and other soil micro-organisms, as well as the root system of plants.* As conclusion the author highlighted that *the anthropogenic action in the agro-systems has modified the soil conditions, diminishing the level of organic matter considerably and, in consequence, the content of free energy that sustains the pedology biocenosis. This has caused a reduction of the structural and functional biodiversity, with the sub-sequent disappearance of a great part of the bonds and functional mechanisms that allow the self-organization of the soil biocenosis. In this situation the conditions are more favourable for a proliferation of opportunist organisms, among them, the plant pathogens.*

Mesa Redonda, 17 de Septiembre de 2004

CALIDAD ECO-BIOLÓGICA DEL COMPOST, APLICACIONES Y BENEFICIOS AMBIENTALES

Marco de Bertoldi (University of Udine), Italy, he said that the European strategy on waste management set up the waste management hierarchy: (1) Reduction of waste production, (2) Recycling and composting, (3) Thermo-valorisation, (4) Landfill. This hierarchy is based on the environmental impact of every practice, intending to reach the general aim of the sustainability. The author emphasized the important role that compost could play in this scenario. It would be of prior importance to produce high quality products. Factors that affect the compost quality are: (1) starting material and its conditioning; (2) the composting system and process; (3) the control of the process. Only respecting all the requirements, it is possible to obtain products compatible with agricultural crops and beneficial to biological fertility of soils. He concluded that the main benefits of compost utilization are: 1. Biological agriculture, 2. Organic fertilizer, 3. Soil conditioner, 4. Contribute to chemical fertilization, 5. Preparation of growing media, 6. Horticultural substrates, 7. Plant nurseries, 8. Control of plant diseases, 9. Beneficial effect on mycorrhizae and nitrogen-fixation, 10. Mushroom production, 11. Reclamation of sandy soils, 12. Viticulture pomology, 13. Recovery of landfills, 14. Biofilters for air depuration and odour control, 15. Prevention of plant disease,
16. Improve soil organic matter, 17. Improve soil porosity and texture, 18. Increase biological fertility of soil, 19. Beneficial to microbial activity in soil, 20. Improve plant nutrient availability, 21. Prevent desertification, 22. Prevent soil erosion, 23. Increase water retention, 24. Reduce leaching of nutrients, 25. Enhance sustainability in agriculture, 26. Reduced costs in organic waste management, 27. Prevent pollution caused by improper waste disposal, 28. Bioremediation, 29. Degradation of toxic organic waste, 30. Waste processing and regenerative life-support medium in human extraterrestrial exploration, 31. Pollution control, public health benefit and resource recovery in developing countries

SUMMARY AND GENERAL CONCLUSIONS

José María Gómez Palacios (Biomasa Peninsular), Spain

1. Soil problems
   - Soil sealing, Hydraulic erosion, Wind erosion
   - Loss of organic matter and biodiversity
   - Industrial farming intensive practices /
   - *Increasing soil conservation knowledge and improved practices*

2. Compost problems
   - Chemical quality: source separation
   - Marketing
   - Lack of biological quality knowledge, criteria and indexes. Inadequacy of composting processes
   - *Eco-biological assessment for compost use: beyond the chemistry and physics*

3. Soil and compost
   - Similar substrates
   - Linked in legislation (Germany, EU)
   - Living mediums / ecosystems / compatibility
   - Similar analytical methods, techniques, tools (molecular, bio-chemical)

4. Eco-biology as a new /privileged tool
   - Development of soil and compost eco-biological health and quality indexes
   - Eco-biology in legislation
   - Development of reliable and available molecular methods
   - Biological cycling of nutrients
   - Controlled microbial composting
   - Microbial ecology / Agroecosystems /Agroecology

5. Use of compost and compost tea
   - Organic amendment, topsoil, cover
   - Slow release fertiliser

- Biological fertiliser / Inocullum for enhance soil dynamics, reduced fertilisers
- Soilborne disease suppression (mainly compost), reduced pesticides
- Foliar disease suppression (mainly compost tea), reduced pesticides
- Systemic, complex effects (especially with compost tea)

6. New way of producing/marketing compost
   - Professionalism
   - Quality in product and assessment
   - Science and technique based
   - Focus on the integration of the compost use with soil and crops