

# **Environmental Management Systems for Organic Wastes Management**

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Environmental management systems (EMS) are tools that help businesses address the environmental impacts of their production activities. A formal framework (ISO14001) exists for the development of an EMS that is 3<sup>rd</sup>-party certifiable, and many industries in the value-added food sector have adopted these systems. In contrast, producers of commodity agricultural products, such as animals, have done little to implement comprehensive EMS's. Instead, such producers have typically relied on codes of good agricultural practice and similar voluntary instruments to address environmental concerns associated with the production of animals and management of the resulting organic wastes. Codes of practice, voluntary as they tend to be, are generally inferior to 3<sup>rd</sup>-party certifiable schemes in facilitating both continuous improvement in environmental management and consumer confidence in food production.

Regrettably, few guidelines exist for developing an EMS for organic wastes management. Although agronomic guidance for the use of nutrients must be an obvious component of an EMS for organic wastes management on land, nutrient use is only one element of comprehensive environmental management.

The project that is the subject of this paper was funded by the Irish Environmental Protection Agency to establish a structure for an EMS applicable to intensive animal producers. In the conduct of this study, an expert panel of scientists, practitioners and producers was drawn together to identify possible approaches. Limited testing of key elements of the resulting EMS was subsequently conducted before finalising recommendations. The resulting "template" for development of an EMS for organic waste management is thorough, yet flexible, with a defined framework that will facilitate a producer achieving independent certification.

In this paper, the elements of an EMS for organic wastes management are presented, as well as the advantages and disadvantages of this approach.

# **Assessing the reuse potential of organic waste products in urban and peri-urban agriculture**

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Demographic growth and urbanisation are some of the biggest challenges of the next decades. In 1994, 45% of the world's population lived in cities, and by 2025 this figure will have risen to 65%. The most rapid change is occurring in the developing world, where urban populations are growing at 3.5% per year. Cities are driving forces in economic and social development. Yet along with the benefits of urbanisation come serious environmental and social problems. These include the lack of adequate water supply, environmental sanitation services and food security. Some of the worst problems occur in the poorest areas where the local governments are unable to provide for even the most basic services and where food insecurity is drawing more and more people to the burgeoning practice of urban agriculture. Currently about 800 million people are involved in urban agriculture and it is estimated that until 2005 urban agriculturists will produce up to 33% of the world food production.

In response to this challenge there is need for a holistic approach to environmental sanitation and urban agriculture. Environmental sanitation usually includes water supply, human excreta, wastewater, refuse, and stormwater management. The link between environmental sanitation and agricultural production is obvious: liquid and solid wastes containing significant amounts of nutrients are valuable fertilisers for producing food and non-food crops in built-up areas. Reusing waste in urban agriculture is usually the most effective way to reduce the demand for waste treatment and disposal provided that public health is not impaired.

The method of material flux analysis is presented in this paper as one possible approach for improved environmental sanitation and urban agriculture planning. This method allows linking urban organic waste flows (supply) and nutrient need in urban agriculture (demand) at the level of a city.

## **Economic Analysis Of Various Animal Waste Treatments In Selected Provinces In Vietnam**

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Within the framework of the Area Wide Integration project in Vietnam, a survey was conducted in four city/provinces in Southern Vietnam in July and August 2002. The main purpose of the survey was to collect information for economic analysis of practical measures in handling animal wastes and the application of manure to crops. A total of 360 households were selected and interviewed (120 livestock farms, 120 crop farms and 120 mixed farms - crop & livestock production).

The survey confirmed that currently, liquid wastes create much more serious environmental impacts than solid wastes that are often recycled on crops or fishponds. A considerable proportion of the interviewed crop farmers apply manure for their crops. The proportion is higher for mixed farms than for simple crop farms. One possible reason is that manure transport is cheaper for the former. This results supports the hypothesis that manure transportation, and more generally transportation costs (related to the siting of the livestock production) are core issues to the concept of area wide integration of livestock and crop production.

Results of financial analysis show that farmers may get benefit from pig waste processing and utilisation. For example, the benefit-cost ratio for the composting of solid wastes is greater than 1. The treatment costs are estimated on the basis of labor and equipment costs. The benefits from composting are estimated from the current market value of manure. This implies that composting could potentially generate profits if farmers can sell the compost. This represents a so-called win-win situation in which society and private farmer could benefit from the activity. However, in some areas compost market do not currently exist. It is suggested that policies to enhance manure market development may create favorable conditions for better animal waste management and reduced environmental impacts.

Other management options, such as biogas production or fresh manure selling also present benefit cost ratio greater than one and should be included as potential options in the development of manure management plans.

# **Integrated evaluation of organic waste management options**

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Livestock farms are among those activities considered more environmentally risky, and on which it is possible to act at different levels, improving the management in order to lower the environmental impact. Therefore, the principles of the Environmental Management Systems, provided for in some binding regulations (Directive CE 96/61) and some voluntary standards (ISO 14001, EMAS), have to be applied. For this purpose it is necessary that the livestock farms perform an analysis of their actual management systems and an evaluation of possible critical points of the production activity. Structural aspects of the livestock farm and, above all, the housing and the manure management systems, represent a focal point of this analysis. Thus it is possible to identify the possible Best Available Techniques (BAT) to reduce the emissions in air, soil, and water allowing a farm to adopt a management system that is environmental safe and economically sustainable. However, the adoption of a single technique should be evaluated in the general context of the farm. In order to give a contribution in this direction, a first tool for an integrated evaluation of actual situation and possible improvement obtainable by applying BAT has been devised and implemented in a software. The preliminary simplified model developed is supported by a database containing the basic information related to the different techniques that can be utilised in a livestock farm, from feeding to manure utilisation. Each technique is characterised by an emission level toward air, soil and water and by the technical and economical feasibility.

Selecting for each sector of the livestock the appropriate set of techniques it can be defined the overall emission level and pointed out the critical points of the farm management. As a second step, the adoption of different techniques can be simulated and different hypotheses of intervention can be compared.

Keywords: IPPC, Best Available Techniques, manure management, intensive livestock

# **Costs And Regulations In Pig Production**

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Environmental policy in Mexico has the objectives to halt deterioration of the environment and to promote sustainable development. An implicit objective is to internalize the environmental cost of productive activities and services through the regulatory approach or “command and control” approach expressed in the elaboration of standards.

The goal of the study is to estimate the environmental cost in pig production, represented by the standard on wastewaters to national waters (NOM-001-SEMARNAT-1996), through the investment on treatment systems and/or the payment of rights when the standard is not achieved. The study was carried on in La Piedad, Mexico, in one of the most contaminated basins of the country. In Mexico water is a critical resource because it's scarce, badly distributed in space, time and among persons and with highly polluted.

Standard NOM-001 has maximum permissible limits for 20 parameters and it's based on a cost benefit study which demonstrates that the standard is economically viable with a secondary treatment.

Per Animal Production Unit (APU=100 Kg. live weight), big farms invested in treatment systems an average of 7.7 USD; medium farms 8.6 USD and small ones, about 10.6. The percentage that treatment systems represented of total investment in farm was: from 0.1 to 11.8 in small farms; from 0.8 to 9.1 in medium farms and from 1.5 to 2.3 in big ones.

All farms in the survey surpass one or more parameters of the standard; pig production requires tertiary treatments to achieve the standard. So, the standard is more expensive for this activity than for others.

# **Review of food waste management in Scotland – a case study**

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In Scotland, and the UK, food waste disposal via macerators (food waste disposers) plumbed into the waste drains in industrial kitchens is common practice. For the National Health Service in Scotland, for example, this paper estimates that up to 5,000 tonnes of food waste is disposed via such macerators, consuming up to 60,000 m<sup>3</sup> of clean water in the process. Apart from the obvious impact on the environment (BOD, energy consumption, oils and fats), there is concern about the release of untreated meat products into the environment (BSE and spread of diseases). At the same time, the sewage handling and treatment systems are operating at full capacity and are in need of refurbishment. The sewerage undertakers consequently do not approve of this technique, but have no means of stopping it at the moment because there is no legal provision for this.

Whilst the use of macerators is either banned or extensively restricted in most European countries, there is no such restriction in place in the UK. The Animal By-Products Regulation (EC 1774/2002) safeguards the health of humans and animals by regulating the spread of animal by-products on land, however it does not regulate their disposal into the sewer. Under the proposed EC Biowaste Directive, a total ban on such macerators is discussed. This legislation is anticipated to come into place during 2004, but implementation in the UK will take a number of years.

Once this legislation is in place, suitable treatment methods will have to be adopted. Currently, composting or energy recovery are discussed as the most sustainable means of dealing with such waste material. There is a need for the UK to adopt best practices from across Europe.

# **Survey on manure management: A valuable tool to assess and optimise farm nutrient cycling and minimise emissions**

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The assessment of the impact of farm manures on ammonia and other environmental emissions is severely limited by the lack of reliable data on current manure management practice. To provide such data, representative surveys on manure management were recently conducted in Switzerland and the UK. In both studies an extensive questionnaire was distributed to a stratified, representative, sample of randomly selected farms grouped into three geographical regions, three altitude zones and four farm types in Switzerland and eight farm types and four farm size categories in England. Extensive plausibility testing confirmed the reliability of the data.

Thanks to the stratified structure of the representative sample it is possible make detailed differentiated assessments (either geographical or farm type basis) of the impact of a wide variety of farm management scenarios. This is valuable for the assessment of ammonia emissions and other environmental risks and for predicting the potential benefits of legislative action or incentives. Moreover, if the survey can be repeated at regular intervals, this will allow the development of farm management practices to be studied over time. Interesting aspects, for example, might be changes in housing systems, in the proportion of livestock excreta gathered in liquid and solid form, changes in land application practice (which crops and seasons, rates etc.), in manure spreading technology and changes in the importance of grazing etc. Such survey data would also allow the interaction between key components of manure management practice to be studied, e.g. storage capacity and application strategy.

Regular surveys on farm and manure management can be a valuable tool for informing research, extension and policy. To guarantee a full use of the potential of such activities it would be important to initiate them in a coordinated and at least partially harmonised approach across Europe and to repeat them at regular intervals.

# Management Manure & Manure Treatment Plant: Present And Future. The Farm School Of Murcia University's Veterinary Science Faculty

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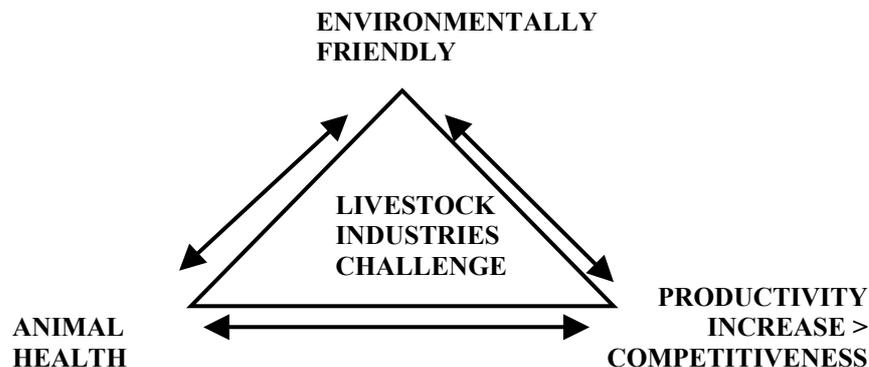
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The new directives set by the production market show that the treatment and appreciation of stockbreeding by-products must be considered from a global standpoint integrating safety, health and respect for the environment. These standards, applicable both to the technology used and to the final product obtained, are vital for maintaining and improving our productivity.

This present work reviews the challenges faced by intensive stockbreeding starting from the traditional problems of manure treatment and compares this situation with a new, more global vision, involving environmental quality, animal health and welfare and productivity, taking as a reference the operation and progress of the first 34 months' running of the manure treatment center facility at the Farm School of Murcia University's Veterinary Science Faculty (Spain).

Apart from the nutrients (nitrogen, phosphorus and potassium mainly) and trace elements (heavy metals, basically zinc oxide and copper sulphate), the manures and stockbreeding by-products stemming from intensive operations pour organic material, ammonia, volatile substances causing foul smells and pathogenic agents, into the environment. Modern animal production is an extremely sophisticated business and the management, treatment, purification and appreciation of its by-products should also be so. As the practice of intensive production in stable or pen facilities grows there is an increasingly urgent need for effective and affordable alternatives for management of nutrient by-products. This work presents an integral system for manure treatment designed and installed by SELCO MC at the Farm School of Murcia University Veterinary School. This system means an undoubted step forward in the technology of manure management and appreciation and vouches for the close inter-relation between production, animal health and welfare and a healthy environment (see Figure 1). We compare the results with another facility in NC (USA) evaluated for Environmental Superior Technology Project Demonstration (AWMP-NCSU) Animal Waste Management Program.



## **Time Course of pH and Basic Cations in Runoff Water Collected in a Forest Plot Treated With Wood Ash**

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Wood-processing industry harnesses, in many occasions, the felling remains (bark, leaves, fruits,...) to obtain energy by burning them in their own factories. This activity produces nowadays huge amounts of wood ash, being landfilled without break in continuity. On the other hand, this residue shows some interesting characteristics such as its high pH level and important concentrations of some essential nutrients for plants that make feasible its utilization in agricultural and forest lands as liming and fertilizing agent. In spite of that, it is important to asses the possible environmental risks of such practises. The time course of pH and basic cations in runoff water collected in a experimental plot located in a gently-sloped forest hill treated with wood ash is described in this work. Comparison of analysis form the control and the treated areas shows the influence of wood ash on runoff water since the studied parameters point of view. However, the results suggests that the applied amendment does not turn out as problematic if the registered levels are compared to those allowed by legislation.

## **Denitrification enzyme assay in a marsh-pond-marsh wetland used for swine wastewater treatment as influenced by alternate wetting and drying cycles**

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Constructed wetlands with continuous vegetative cover (marsh) have been documented to be very effective for denitrification of nitrogen in swine wastewater. Generally, the limiting factor for denitrification in such wetlands is slow formation of nitrate via nitrification because anaerobic soil conditions are prevalent and ammonia is the major nitrogen component in swine wastewater. It has been postulated that the shallow pond section of constructed wetlands with marsh-pond-pond designs would promote nitrate formation and subsequently denitrification. However, experimental results have shown the marsh-pond-marsh wetlands to be less effective for removal of nitrogen. Thus, we investigated enhancing soil aeration and the associated nitrification by short interruptions of wastewater application. The procedure was a one week drying cycle followed by one, two, or three weeks of wastewater applications vs. continual application. The study was conducted in 2002 at North Carolina A&T State University on marsh-pond-marsh wetlands with flat bottoms and cattails vegetation in the marsh sections. We measured soil redox, nitrogen treatment efficiency, and denitrification enzyme potential. Soil redox condition was more oxidized in the 1:1 cycle, but the conditions were not sufficient to promote higher treatment efficiency. However, there were highly significant increases in DEA values from addition of nitrate. Furthermore, when nitrate was added, there was a good linear correlation between percentage of time in the drying cycle and the level of denitrification. Effective use of a pond section in constructed wetlands will likely require altered design.

# **Survey on manure management in southern Piedmont region of Italy, new rules and following potential future strategies**

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The Council Directive 91/676/CEE concerning the protection of water against pollution caused by nitrates from agricultural sources has generated in Italy a new national and regional legislation relevant for the manure management in agriculture.

In accordance to the Directive, and following national and regional laws and decree, “vulnerable zones” have been identified on the Piedmont regional territory.

In these zones it is not possible to spread on fields more nitrogen than that required by the crop on the basis of a nutrient balance, and 170 kg/ha is the maximum quantity of nitrogen that is possible to supply to the crop. Minimum limits are set for manure storage as well as other restrictions related to nitrogen distribution.

These new rules have a great impact on animal production farms. For this reason in 2003 the regional administration of Piedmont has started on an environmental monitoring action on livestock farms to evaluate the effect on the farm management of the new rules.

Earlier data on environmental monitoring on 68 pigs farms in vulnerable zone in Cuneo province, in southern part of Piedmont region, are at the moment available. These farms have roughly 6,800 tons of liveweight of pigs, 3,450 ha of land for the landspreading and 8,900 m<sup>3</sup> as manure storage volume. Near all farms do not have enough land for the application of farm manure respecting the limit of 170 kg/ha of nitrogen allowed for land distribution to crop. Only 13 farms satisfy the new minimum manure storage capacity established by the new rules.

The survey on a larger number of animal production farms is going on. In spring 2004 greater number of data will be available and the paper will discuss the different options on manure management strategies, application and treatments, livestock farms in vulnerable zones have to adopt to comply with new environmental rules. Economic aspects are examined.

## **Animal Waste Management In Vietnam – Problems And Solutions**

(Parts of AWI project - Area-wide integration of specialized crop and livestock activities in Vietnam; funded by LEAD - FAO)

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As parts of the AWI project in Vietnam which was conducted in four city/provinces of Southern Vietnam, we surveyed animal wastes management on private small- and middle-scale farms and evaluated practical measures to improve manure handling.

Chicken manure is considered as high-value fertilisers for coffee, pepper, or orchards such as longan and grape-fruits. Besides, chicken manure is widely utilised for biogas or fish feeding. Cattle solid wastes are mostly collected and utilised for elephant grass, bonsai, coffee, pepper, or fruit plants. Farmers can sell fresh chicken and cattle manure to manure traders. Cattle liquid waste may be used for biogas or irrigation of elephant grass. Unlike chicken and cattle manure, pig solid wastes are not widely used for fertilisation. Disposal of wastes in swine production has remained a headache to enterprise owners as well as the authorities. Some successful measures of pig waste management are biogas, fish feeding and use as fertiliser, or to improve quality/structure of crop land.

Some possibilities to deal with liquid wastes are suggested including the establishment of markets for pig manure, education, awareness development and strong legislation. Farmers should reduce the volume of water used in animal house by collecting solid manure before house washing, and applying air cooling systems to minimise water volume used to cool animals. Collection and transport of liquid wastes to cultivation areas should be considered. Relocation of animal farms to remote and agricultural areas is also a solution. At the moment, government has some programs to support and encourage the relocation of state farms.

In this project, experiments using pig manure for fertilisation of a dominant local cultivation were also carried out. The experiments did not show positive effects of manure used on rice while both pig compost and biogas sediment induced an increase in peanut harvest up to 25%, and in vegetable yields to 53%. Pig wastes also enhanced the yield of longan and had a positive influence on the growth of rubber tree.

## **Concepts of valorization of dairy farm wastewater**

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All agricultural enterprises face the challenge of ensuring the sustainability of their resources while competing against low world market prices. Furthermore, global warming is bringing new environmental challenges such as a dryer and warmer climate for Eastern Canada. In response, two systems were devised to reduce farm wastewater management costs while valorizing their crop benefits. Since such wastewaters have a low nutrient value, conventional land disposal methods (tractor and tanker) are relatively expensive.

For the farm with a conventional manure seepage and wash waters collection system, a surface irrigation technique was developed to apply such wastewaters to 1,0ha of cropped land near the storage facility. The amount of wastewater applied is based on crop nutrient needs, representing 150mm of irrigation waters, which are unavailable in mid summer. This technique reduces the disposal cost and spreading time of such wastewaters by 75%, but requires a field with a regular slope over at least 75m and several subsequent applications, leaving enough time in between for the absorption of the wastewater applied, and; the installation of a ground water control system to hold the 0,5% volume and nutrients losses by direct infiltration when the field is drained by a subsurface drainage system.

For farms without a manure seepage collection tank, a modified seepage field was designed to treat milk-house wastewaters using a septic tank. Built on limited land, conventional seepage fields, result in soil clogging from saturation and groundwater contamination from the continual build up of non-volatile minerals. The modified seepage field covers 0,5ha of land to reduce incidences of soil saturation and to distribute the wastewater nutrients for crop uptake, thus reducing incidences of long term nutrient ground build up. At the same time, this sustainable systems costs 50% less than the other alternatives such as filtration beds and wetlands.

## Alternative raw materials of cellulose pulp from agroforestry residues

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Over the last few years, paper consumption and, consequently, production have notably increased, growing the demand for fibrous raw materials to papermaking and their associated environmental problems. Due to all these considerations, research on alternative raw materials, such as agricultural and agroforestry residues, is being carried out, as well as development of manufacture of cellulose pulp manufacturing by using low-pollution methods, “clean technologies”.

Chemical composition of fourteen raw material from several species of agroforestry have been studied, leucaena (5 varieties), *Chamaecytisus proliferus* (4 varieties), *Retama monosperma*, *Phragmites*, *Arundo donax* and *Prosopis* (2 varieties).

Characterization experiments involved the following parameters; 1% NaOH solubles (Tappi 212), ethanol-benzene extractives (Tappi 204), hot water solubles (Tappi 257), lignin (Tappi 212), holocellulose by Wise et al. method and  $\alpha$ -cellulose (Tappi 203-OS-61).

Summary of chemical characterization are shown in the table 1.

**Table 1:** Results from chemical characterization

Raw material	1% NaOH %	ethanol-benzene extractives %	hot water solubles %	lignin %	holocellulose %	$\alpha$ -cellulose %
<b>Leucaena</b>	17.4-23.4	4.4-8.2	3.2-6.8	17.0-21.4	68.3-80.8	39.4-44.4
<b>Chamaecytisus proliferus</b>	15.5-16.7	2.2-3.4	2.4-3.0	14.1-16.8	75.4-82.2	43.6-47.7
<i>Retama monosperma</i>	16.9	5.0	3.8	21.5	71.8	42.7
<i>Phragmites australis</i>	34.8	6.4	5.4	23.7	64.2	35.8
<i>Arundo donax</i>	26.8	7.3	4.7	22.3	60.2	40.5
<i>Prosopis</i>	20.9-22.6	4.7-5.3	4.7-6.5	19.3-20.6	62.8-63.6	36.5-41.5

\*Percentages with respect to initial raw material (100 kg o.d.b.).

Given the average values found in composition, the analyzed materials could be adequated to made cellulose pulp.

## **SPREADS - controlling the costs and efficiency of manure and slurry spreading on farms**

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A decision support system (DSS), SPReader Economic Assessment and Decision Support (SPREADS), capable of assessing the costs and associated performance characteristics of a range of manure and slurry spreading techniques has been developed. The system makes use of published information on machine performance and costs. Gaps in the available information have been supplemented by expert knowledge and, in some cases, field performance assessments.

A database contains information on a wide range of application systems, including some of the new, surface placement techniques designed to improve application precision and reduce emissions following slurry application. Umbilical supply systems are also covered, as well as an option for hire or contracting services. The software contains a library of key components needed to represent a spreading system, e.g., tractors, spreaders, etc. Default values are available, but the financial and performance attributes of the components can be edited to user requirements. Operation of the software has been simplified by the provision of sample systems, allowing the user to select and modify the system closest in detail to the one of interest.

A model has been developed within the DSS that calculates the economics and work rates involved in the application of manures to land and the breakdown is displayed in both graphical and tabular format. Initial validation of the model, carried out against an existing Dutch DSS, has shown good agreement of outputs on costs and work rate, where simulations are based on the same assumptions. The risk of inappropriate system design within SPREADS is minimised by the implementation of extensive logic checks.

“SPREADS” is a potentially valuable aid to improved manure management, allowing farm-specific analyses to be conveniently and rapidly undertaken. It is anticipated that SPREADS will find wide application with agricultural contractors, farming consultants and policy advisors as well as research scientists.

# Technology for the slurry spreading and environmental protection

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The presented material make possible to learn about the technology of application of liquid manure (from stock farm) in Estonia in the time of ripening of field crops considering the efficiency of effect of fertilizers on the growth of plants and at the same time on the increase in their yield and reducing at that the harmful influence of the emission of ammonia on the environment as much as possible.

The Estonian Research Institute of Agriculture has developed a design of machine and produced two prototypes (6t and 10 t) of a spreader with trailing hose type facility. At that the price of the machine is considerably lower than the market price of today. The machine operating width of distributing working head of 12 m of end application has been made for a specialized pig breeding complex on the basis of which both intake and operational testings of the spreader and technological studies and testings of application of pig slurry to grain crops during their growing period from the beginning (at the outset of sprouting phase, the height of plant being 20-30 cm) have been carried out.

Spreader. Results obtained by a number of testings was show, that from has to be mentioned in particular that in case of immediate contact of fertilizers with soil coming from distribution hoses dragging on the surface of the field to be fertilized we can succeed in reducing noticeably the emission of ammonia by 40-60% which will evaporate during fertilization by using Splashplate-type sprinkling nozzle.

Agrotechnical Indicators. By observations it has been established that mechanical damage (or lodging of plants) due to the contact with hoses has been minimal, at that the lodging recovery took place in a short while. Pollution of plants by fertilizers has been minimal and dependent on the space between drills. It has been established that an optimal space between drills must 20...30 cm.

Table 1: Effect of Pig Slurry on the Yield of Crops

Crop	Yield t/ha		Effect of slurry	
	Without slurry	With slurry	t/ha	%
Barley	2.82	3.60	0.78	28
Spring wheat	2.75	3.18	0.43	16
Spring rape	1.88	2.65	0.77	41
Winter wheat	2.35	2.88	1.10	47
Rye	2.00	2.83	0.83	42

Obtained results will illustrate effectiveness of the method of fertilization at a rather satisfactory distribution of fertilizers in the field and the reduction of the emission

# Human Excreta - a Valuable Resource

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Ecological Sanitation (EcoSan) presents an alternative way of looking at and managing human excreta in a more beneficial and environmentally friendly manner. The EcoSan approach to human waste disposal allows recycling, recovers the much-needed nutrients to increase soil fertility and increase crop production, while minimising environmental pollution problems.

In line with the lack of reusing guidelines the Kawanda Agricultural Research Institute are developing guidelines for handling and management of human excreta as organic manure.

## Methodology

To generate sufficient materials for field evaluation 4 stances of diverting dry toilets are built at KARI. In addition to collection chambers, a separate storage room for pathogen monitoring is constructed.

In order to promote use and create a sense of ownership of the facility, community sensitisation will be necessary on its proper use and maintenance. This will take the form of open meetings, which will begin during the construction phase of the dry toilets both to raise awareness and to take into consideration the interests and views of the users.

For the first phase of the research work, investigations for re-use of excreta in agriculture will be carried out on-site. Fresh urine will be tested for nutrient content and stored in a closed drum. At the end of the storage period, it will be tested and diluted with water in different ratios and applied on crops.

Faeces will be desiccated using wood ash and kept in a well-ventilated storage room and the pathogen content monitored until (complete) elimination. The mixture of faeces and ash will be composted with other materials and depending on nutrient content, applied on coffee and maize at various rates.

## Expected output

- pH and nutrient composition of the urine, faecal material, soil medium and plants.
- Pathogen content in urine and faeces at different stages.
- Crop growth parameters and vigour, duration to flowering, maturity and crop yields.
- Economic benefits.

# **Multiple criteria assessment of manure management technologies for confined pig production in rapidly growing economies**

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The fast rising demand for livestock products has lead to a considerable increase in livestock production, mostly taking place in rapidly growing economies. This results in high environmental pressure. If there is a wide range of techniques to manage pig manure to meet an equally wide range of purposes, they are often known locally. Besides, the processes, requirements and their implications on the environment and public health are most often insufficiently known. As a consequence, it is difficult for decision makers (e.g., farmers association, extension services) to design optimal technological packages according to given objectives and context. Therefore, the purpose of this study is to describe and assess pig manure management technologies (manure collection, storage and process) to facilitate their identification and selection.

A literature review was first carried out. Each technique was considered separately, process, design and requirements were described. A set of 24 criteria was then selected: it included not only treatment efficiency but also other such as technique requirements and environmental issues. A “ranking exercise” was finally conducted in which each technique was given a score for each criteria. This was supported by a specific workshop.

Table 1 gives an example of the scores given for the BOD removal criteria. In this way, decision makers can have a quick overview of how different techniques perform on given criteria.

The information gathered will be the basis for a multiple criteria evaluation of manure management options (combination of technologies). Indeed, the LEAD initiative intends to prepare a Decision Support Tool for pig manure management in rapidly growing economies which will (1) give information on selected technologies, (2) propose a set of potential manure management options for given objectives / contexts and (3) propose a “manure management self learning tool”. A preliminary version of the DST should be available in September 2004 for demonstration.

# **Strategy for livestock waste processing into microbial fertilizers to solve environmental problems**

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It is expedient to consider organic waste from livestock farms as additional product, from which one can obtain new types of microbial fertilizers using active microorganisms. This research strategy has been actively developed in Russia, where the annual volume of livestock waste is about 400 million ton (Arkhipchenko, 2000).

On the basis of experiments conducted by us in 1986-2003 the possible directions to use these fertilizers both in organic farming and to improve environment situation are shown.

In organic farming these fertilizers can be used:

- to suppress phytopathogenic microflora;
- to increase the crop yield and crop quality;
- to increase soil fertility.

To improve environment situation the microbial fertilizers can be used:

- for reclamation of man-destroyed soils,
- for destruction of oil contamination by 60-90%,
- for intensification of the biological decomposition of organic municipal wastes during their composting,
- as an alternative to pesticides, because the fertilizers reduce plant damage caused by pests in 4-5 times.

Practical examples of the fertilizer application results are shown and the expediency of microbiological processing of livestock waste for microbial fertilizers is scientifically grounded.

# **International guidelines for agricultural use of human urine and faeces**

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International guidelines are presented for the agricultural use of human urine and faeces based on a literature study and the current knowledge of use of urine and faeces in small and large scale cultivation. The guidelines have been developed within the framework of EcoSanRes, an international network of ecological sanitation expertise funded by Sida, the Swedish International Development Cooperation.

A basis for the recommendations for agricultural use is the knowledge of the contents of nutrients in the excreta, the amounts excreted, composition and plant availability of the fertiliser, as well as the hygienisation treatment of the products, which influences the properties. Data that can form a basis for adapting the guidelines to local conditions is presented in the text.

Recommendations for agricultural use of urine and faeces should be based on local recommendations for fertilisation of crops. Urine is a quick-acting nitrogen rich fertiliser that can be applied neat or diluted. Care should be taken to minimise ammonia losses at spreading, mainly through quick incorporation of the urine into the soil. Faeces are rich in phosphorous, potassium, micronutrients as well as organic matter. The faeces should be applied and mixed into the soil before cultivation starts. The best fertilising effect is achieved if urine and faeces are used in combination with each other.

Lack of documented research in this area makes the development of set guidelines difficult. Still, the products have been used in agriculture since ancient times, and there is a lot of undocumented knowledge based upon practice. Research on the use of urine and faeces as fertilisers is needed, especially in the following areas:

- Nutrient effects of excreta on crops and soil
- Fertilisation strategies and application techniques when using excreta
- Efficiency of storage of urine in soil
- Simple and resource-efficient sanitation techniques for faeces

## **Calculation of Unit Cost for Techniques for the Reduction of Ammonia Emissions from Livestock Production**

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The purpose of this paper is to provide information on the additional costs incurred by farmers for measures to abate ammonia emissions for livestock systems under Spanish conditions. The information is intended to be used to contribute to the calculation of the most efficient methods of reducing ammonia emissions from Spanish farms. This is a requirement of both the IPPC Directive and the UNECE Gothenburg Protocol. The costs shown in this report relate to the extra costs for farmers with production and management systems that are typical for the country. For each abatement technique the typical (or reference system) is described in addition to the changes that needed in order to reduce emissions. The calculations have been carried out according to the methodology set out in the IPPC Reference Document on Best Available Techniques (BAT's) for Intensive Rearing of Poultry and Pigs.

This is a previous work required to provide a basis for the calculation of the environmental benefits and the costs when several BAT's are implemented in the same livestock system. In the future, the development of a program that integrates these data to support the work of technicians and the authorities should be considered.

## **Implementation of the IPPC directive in the pig and poultry sectors in Spain. The MAPA approach about the current status and future work.**

**M. Bigeriego<sup>1</sup>, G. Montalvo<sup>2</sup>, C. González<sup>2</sup> y C. Piñeiro<sup>3</sup>, M. Herrero<sup>4</sup>, R. Giráldez**

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The objective of this paper is to describe the current situation in the Spanish pig and poultry sectors regarding the control of pollution and emissions described in the IPPC directive and the approach of the Spanish Ministry of Agriculture, Food and Fisheries for its implementation.

In the latest years the Spanish working group, lead by MAPA and Tragsega and conducted with the support of experts of the sector, have been involved in the discussion of the draft and the later development of a technical guide for its implementation in the producing sector. The aim of this guide is to provide comprehensible, accurate and easy information to technicians and farmers and will be updated periodically with future research. This knowledge will be based on a two years research project (2004-2005) to determine gaseous emissions, mainly ammonia under commercial conditions, and the influence and costs of different BAT's (Best Available Techniques). Both for the guidance and the future work, the influence of Spanish conditions and the principle of cost-effective techniques have been strongly considered in the selection of the BAT's to be evaluated in the different production stages (feeding, housing, storage and spreading).

# **Organic waste management in agricultural and food processing industry in Poland**

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Organic waste management in agricultural and food processing industry is considered one of environmental priority issues for Poland in the EU accession process. The main aim of the paper is to give an overview of the current state of organic waste management in agricultural and food processing industry in Poland with particular reference to the implications of the EU policy. The paper also presents solutions and recommendations for organic waste management that are necessary to comply with EU policy.

The scope of the paper includes: (1) legislation on organic waste management, (2) the current state of agricultural and food processing industry and its environmental impact, (3) characteristics of organic waste and treatment methods, (4) organic waste management facilities, (5) organic waste potentials for renewable energy, (6) financial support programs, (6) solutions and recommendations for organic waste management in agricultural and food processing industry. Further more, the paper discusses the implications of the EU legislation for organic waste management in agricultural and food processing industry with special emphasis on animal by-products treatment.

Fulfilling the EU legislation requirements on organic waste management in agricultural and food processing industry can be achieved by (1) carrying out registration and control of organic waste generation in all agricultural and food processing plants, (2) implementation of collection system for organic waste from agricultural and food processing industry, (3) increasing organic waste recycling, (4) applying organic waste treatment methods other than landfilling, (5) developing a strategy for sanitary inspection of animal by-products generation and utilization.

## **Ecological Sanitation and Urban Agriculture – TepozEco Project, Mexico**

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The presentation will show how nutrient recycling and water conservation is achieved by strategically linking ecological sanitation and urban agriculture.

The TepozEco Urban Ecosan Project is being carried out in a municipality of 33,000, with about half in the urban hub with no effective sewage and wastewater treatment. Most households have poorly designed and maintained septic tanks, while a significant segment have pit latrines or no sanitation facilities at all.

TepozEco is made up of five work teams focused on: water supply & conservation, ecological toilets, environmental education and urban agriculture & composting.

The last area, Urban Agriculture (UA), is defined as agriculture carried out within an urban area as well as on its periphery. Its principal characteristic and what differentiates it from rural agriculture is the intense exchange in economic terms and of water and organic material -- from tree pruning, kitchens and excreta (urine and faeces) from dry toilets.

The UA unit has provided technical support in establishment of a Municipal Composting Center; and experiments are carried out in applying urine (both fermented and non-fermented) in compost piles primarily of woody materials. The compost material from the composting center has been evaluated. Experiments are also carried out in the secondary treatment of faeces, based on high-temperature composting.

During 2003 initial field tests were conducted applying urine as a fertilizer to corn, nopal cactus and avocado, primary crops grown in the municipality. In 2004 these efforts will be expanded --including tomato and flowers--, and progress will be made in a system of collection, transportation, storage and application of urine in fields.

Cultural acceptance of the above has not been that difficult. Capturing the interest of farmers in using this practice depends to a large extent on the quality of information received by the population and on field demonstrations.

## **Proposals for the management of yard wastes in the Vallès Oriental region**

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The Vallès Oriental is a Catalanian region with an area of 851.9 km<sup>2</sup>. It has 295,000 inhabitants and 132,000 non-permanent residents distributed in 43 districts. The region has two major cities with population over 50,000 inhabitants (Mollet and Granollers) while the other towns have less than 15,000 inhabitants. In smaller districts the most common dwellings are detached houses with garden. Maintenance of these gardens results in the production of large amount of yard wastes. Management of these wastes is the problem addressed in this work.

A survey was carried out in 38 districts of the region, which constitute the Consorci de Residus del Vallès Oriental. Seventy-six per cent of the districts acknowledge having large amounts of yard wastes with their main destination being landfilling. Nowadays 8 districts have started source-separated collection systems for yard wastes to be composted.

Results from this study and other data have been used to propose different options for the management of the yard wastes produced in the region with composting considered as the final process. Shortly, three alternatives have been considered:

- Selective source-separated collection.
- Delivery to municipal storing places.
- Backyard composting. Composting of mixtures of organic fraction and yard wastes was carried out to demonstrate the viability of the process.

Processing could be carried out in:

- The composting plant of the Consorci per a la Gestió del Residus del Vallès Oriental, located in Granollers.
- Municipal storing places modified to store and/or composting yard wastes.
- Centralised areas designed for the composting of yard wastes.

Destination of the final product, either compost or mulch, will depend on the collection system selected. Possible destinations include marketing, application in the same districts or giving it away to garden owners. It is also proposed that all phases can be managed either by public or private entities.

# Shallow Injection of Slurry in Open and Closed Slots on Ley – Technology, Placement of Slurry and Ammonia Emissions

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The main objective of the present study was to evaluate different injection methods for slurry on ley established on various soils. In full-scale experiments the placements of the slurry as well as ammonia emissions and yields were measured after injection in open slots with three techniques: pressurised injection (PI), shallow injection with V-shaped discs (SIO1), and shallow injection with two angled discs (SIO2). The performance between the injectors varied and only the SIO2 was able to place the slurry in ley below soil surface on all three soil types. The ammonia release was on average halved after injection with SIO2 compared to band spreading, however there was an average loss of 19 kg N ha<sup>-1</sup>, Table 1.

**Table 1.** Mean nitrogen lost as ammonia after spreading of cattle slurry on ley during three years, using different spreading methods. The loss is presented as kg [N] ha<sup>-1</sup> or in % of total ammoniacal nitrogen [TAN] applied

Application method	Nitrogen loss as ammonia							
	Year 1		Year 2		Year 3		Average	
	Kg [N] ha <sup>-1</sup>	% of [TAN] applied	Kg [N] ha <sup>-1</sup>	% of [TAN] applied	Kg [N] ha <sup>-1</sup>	% of [TAN] applied	Kg [N] ha <sup>-1</sup>	% of [TAN] applied
PI	31	65 <sup>a</sup>	35	74 <sup>ab</sup>	38	69 <sup>ab</sup>	35	69 <sup>ab</sup>
SIO1	40	83 <sup>a</sup>	48	101 <sup>a</sup>	25	50 <sup>ab</sup>	38	78 <sup>a</sup>
SIO2	16	33 <sup>a</sup>	23	49 <sup>b</sup>	18	34 <sup>b</sup>	19	39 <sup>b</sup>
BA	21	44 <sup>a</sup>	45	95 <sup>a</sup>	45	82 <sup>a</sup>	37	75 <sup>a</sup>

<sup>a, b</sup> Means with different letters within each year are significantly different ( $p < 0.05$ )

A tine for shallow injection in closed slots (tubulator) was therefore developed. In small scale with single tines, the tubulator was compared to SIO2 with regards to slurry placement, ammonia emissions and draught requirements. Ammonia losses after injection with the tubulator tine were only 1.6% of the total applied ammoniacal nitrogen (TAN) compared to 27% with the SIO2.

The draught requirement for the tubulator was roughly the same, or a little higher than the SIO2 tine. However, the tubulator had an advantage under all soil conditions, as the tubulator tines needed significantly lower forces to be pressed into the soil than to the SIO2 tine.

In the full-scale experiments, the reduced loss of ammonia nitrogen with SIO2 did not result in higher DM yield or higher nitrogen efficiency of the second cut as compared to band spreading.

## **Results of the italian national research programme on: “Recycling the wastes of the agro-industrial system”**

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The Italian national research programme on the agro-industrial effluents has come to an end. This programme had the goal to define and promote new technologies transferable to the industrial sector in view of their production and distribution for agricultural use, in order to define strategies for agronomic valorization of the wastes and develop technological innovations.

The study was defined in 1996 and started its activity on Nov. 1st, 1998 involving 30 research units, 30% of which belonged to the manufacturing sector. The first results were shown on the occasion of RAMIRAN 2000.

The specific goals of the programme were to solve the problem of environmental protection through the diffusion of appropriate and innovative processes and technologies making it possible to utilize by-products completely. This, in any case, will also implement the E.U. directives in force.

As far as animal slurry is concerned, the goals are as follows:

- identification of solutions making it possible to eliminate water pollution due to direct discharge of wastes and of new technologies able to reduce and keep under control non point pollution sources through the optimization of the agronomic use of effluents;
- definition of technological packages for an appropriate field distribution with low environmental impact.

At the end of the research activity interesting results have been obtained.

In particular new prototypes of machines and plants as well as some information programmes for the more appropriate management have been designed and constructed. A DVD has been made in order to show the machines and equipment realised within the framework of the Project, at work.

## **Liming with slurry enriched with calcium carbonate used like bedding material in a dairy cow stall**

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The calcium carbonate used like bedding material in a ecological Galician dairy farm “Arqueixal”, increased the calcium concentration in slurry from 1.9 % on dry-matter basis (DM) in the year 1998, until to 7.1% in the year 2004, and therefore improved its liming value. The effect of this calcium enriched slurry on the soil pH is studied in 29 plots during three years. After of 3 years of slurry enriched application on Arqueixal farm plots, the pH raised from 6.38 to 6.54 (weighted median of 29 plots). 15t of calcium carbonate was used by year in the stall, for 30 dairy cows (0.5t of calcium carbonate by cow and year). Although pH slurry do not varied (7.4), it will be desirable to asses if exit more losses of NH<sub>3</sub> because the addition of an alkaline product could elevate the pH and therefore the losses in alleys, slurry pits or in land application.