The importance of agriculture in global waste

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Each year 2-4 billion people dispose of their solid waste by uncontrolled dumping. The majority of these are located in developing countries and generate waste with high organic content, typically 60-80% by weight is putrescible. The paper focuses on the small communities within this group, generally towns of <20,000 population. Currently, the uncontrolled dumping leads to significant emissions of methane and CO_2 as a result of the anaerobic processes in the dumped waste. A series of projects in Minas Gerais, Brazil, have demonstrated an appropriate methodology for collecting this waste, composting it and using it in agriculture. This was initially set up to generate income via recycling and the produce a material to enhance soil fertility. Additional aspects which have been realised subsequently are the savings in greenhouse gas emissions (equivalent to more than 50 tonnes of CO_2 per day) and the sequestration of the carbon in the soil which also has substantial environmental gains. The final part of the paper looks at the potential global impact of using this waste management methodology in terms of overall CO_2 reduction.

Nitrogen and phosphorus excretion by UK dairy cows.

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Reliable quantitative data on nitrogen (N) and phosphorus (P) excretion by housed livestock are essential for many research and policy issues in the UK including national inventories of pollutants (e.g. ammonia), codes of practice relating to utilization of manures, and stocking rates in controlled areas (e.g. NVZs and ESAs). Dairy cows are particularly important because of their high numbers (c. 2.7m milking cows and >10m cattle in total) and their substantial normal excretal production which represents a high proportion of the total from housed livestock. Current "standard values" for excretal output are associated with considerable uncertainty, being variously derived from analyses of stored manures, relationships between diet and excretion and/or limited measurements from animals fed experimental diets. Moreover, recent studies involving quantitative estimation of dung and urine excretion from groups of cattle on commercial dairy farms suggested that current UK standards overestimate annual excretal N output by c. 25%.

Information on feeding and fertiliser practice, milk production and dairy herd management was collected from 87 commercial dairy farms throughout England. A database of nutrient inputs and outputs for these farms has been established for the year 2001. Farm gate balances (accounting for feed and fertiliser inputs [partitioned for dairy and other e.g. arable enterprises] and outputs in milk and animal exports) were constructed to provide a simple means of determining nutrient surpluses and efficiencies within the production system and, consequently, excretal nutrient losses:

N/P Inputs – N/P Outputs = Excretal N/P

Preliminary results show considerable variation between farms:

	Mean	Range
Herd size (cows)	120	47 - 323
Milk output (litres/year)	867,098	270,799 - 2,285,350
Milk N output (kg N/year)	4,521	1,385 – 11,794
N imports		
- purchased fertiliser (kg N/year)	19,368	6,250 – 78,270
- purchased feeds (kg N/year)	10,205	0 – 35,950

Relationships between inputs and outputs and apparent efficiencies of nutrient utilisation together with consolidated estimates of N and P excretion will be reported.

Evaluation of compost efficiency for soil carbon storage based on biochemical fractionation of their organic matter: validation using long term experiments

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Intensive agriculture is responsible for the decrease in organic matter observed in many loamy soils of Ile-de-France. In this region, composts issued from the treatment of municipal organic wastes are used in agriculture to restore soil organic matter content. An index of biological stability (IBS), based on the biochemical fractionation of organic matter in soluble, cellulose, hemicellulose and lignin fractions, is currently developed and under standardisation in France. This indicator represents the proportion of total organic matter of an organic amendment contributing to the upkeeping of soil organic matter.

A long term field experiment has been initiated in 1998 located in Ile-de-France nearby Grignon. Three urban composts (municipal solid waste compost, MSW; sludge compost, GWS, biowaste compost, BIO) are compared to a farmyard manure (FYM). The organic amendments are applied every other year in September after wheat and before maize cultivation. Similar amounts or organic C are applied in all treatments (Table 1). The organic amendments have been analysed, including their C mineralization during soil incubations and their IBS (Table 1). A larger increase in soil organic carbon was observed with the BIO and GWS composts that were characterized by the largest IBS (Table 1) and the lowest C mineralization. The mass balance of organic C in the different organic treatments of the field experiment was used to validate the IBS as a valuable indicator of compost efficiency for soil carbon storage.

Table 1. Total organic C input after 2 organic amendment applications, mean IBS of the organic amendments and evolution of organic C storage between 1998 and 2002 in the organic treatments of the field experiment.

Treatment	C added (T C per ha)	IBS (% of compost OM)	Soil C stock in 1998 (T C per ha)	Soil C stock in 2002 (T C per ha)
MSW	8.3	35	40.9	42.6
BIO	7.0	65	41.2	44.2
GWS	6.5	75	40.6	44.8
FYM	7.5	52	41.8	43.4
Control	0	-	41.0	38.2

Pig slurry application on alfalfa: what can we gain in terms of carbon cycle?

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Alfalfa (*Medicago sativa L.*) normally obtains most of the nitrogen (N) needed for its growth by establishing association with N-fixing bacteria. Yet, when nitrate-N is abundantly available, alfalfa decreases the rate of symbiotic N_2-fixation and removes considerable amounts of nitrate-N from the soil. Owing to such characteristics, alfalfa is well suited to receive manure application and to be included in crop sequences in areas with intensive livestock activities, where the overuse of manure may lead to nitrate contamination of surface and groundwater.

A field experiment, comparing several rates of pig slurry applications to alfalfa (N0 N300, N450 N600, in Kg N ha^{-1} $year^{-1}$), was conducted in 1994 and 1995 in S.Prospero (Modena), Low Po Valley, Northern Italy. The aim of this paper was to evaluate the results of this experiment form the standpoint of the carbon cycle. Two major benefits can be highlighted: i) an increased CO_2 sink due to higher biomass production achieved with pig-slurry fertilization; ii) a virtual reduction in CO_2 source taking into account the "indirect CO_2 emission" required for the manufacture of the mineral fertilizers that would be necessary to achieve the same yield increase.

Overall, as a result of two years of pig slurry fertilization, the optimal rate of application (i.e. 450 kg N ha^{-1} $year^{-1}$) increased the dry matter (DM) forage yield of 6.0 t ha^{-1} and the nutrient removal of 166 kg N ha^{-1} and 25 kg P ha^{-1}. We point out that a "working coefficient for slurry application" can be appraised by taking into account both the increased dry matter production and the increased N and P removal. In the first instance, 6.0 t DM ha^{-1} require a net sequestration of 9.9 t CO_2. In the second instance, assuming a fertilizer recovery fraction of 0.5 for N and 0.2 for P, an equivalent gain in forage production (and nutrient uptake) would require an application of 332 kg N and 294 kg P_2O_5 as mineral fertilizers. Thus, the emission of about 1193 kg of CO_2 ha^{-1} from fossil fuels would occur if mineral fertilizers were applied in substitution of pig slurry. This additional amount, however, is only 12% of the gain in CO_2 sequestration achieved with the higher forage production allowed by pig slurry application.

Effect of multi-year surface-banding of dairy slurry on grass

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Banding slurry manure on the soil surface is easier and less damaging in forage stands than injection. Probably by reducing ammonia loss, surface banding increases short-term yield compared to broadcasting. However, the long-term effect of surface-banding manure on grass N response has not been reported. This study compared the effects of commercial fertilizer with drag-shoe applied dairy slurry on yield and N uptake of tall fescue (*Festuca arundinacea*) in years 7-8 of a trial in south-coastal British Columbia, Canada.

At equivalent rates of total ammoniacal-N (TAN), grass yield was greater with manure than fertilizer whereas at equivalent rate of total-N (400 kg ha^{-1}) yield was greater for fertilizer (Table 1). N-uptake was 6 kg ha^{-1} greater from manure than from fertilizer at 200 kg TAN ha^{-1} and 11 kg ha^{-1} greater at 400 kg TAN ha^{-1}, suggesting a relatively small benefit from previous applications of N. Apparent N recovery for both fertilizer and manure was about 80 and 70% at 200 and 400 kg TAN ha^{-1}, respectively. Alternating manure/fertilizer (400 kg TAN ha^{-1}) produced high yield and N-uptake with less applied total-N than manure alone.

It is not known whether the soil has reached equilibrium. Data (not presented) show more soil organic matter and losses of nitrous oxide but less leaching from manure than from fertilizer.

Table 1. Effects of commercial fertilizer and banded dairy slurry at different N application rates on yield, N-uptake and N concentration of tall fescue.

	TAN	Total-N	Yield	N-Uptake	N concentration
	kg ha^{-1}		t ha^{-1}	kg ha^{-1}	%
Control	0	0	5.5e[1]	92d	1.7d
Fertilizer	200	200	11.4d	256c	2.2c
	400	400	13.4b	362b	2.7a
Manure	200	400	12.1c	262c	2.2c
	400	800	15.0a	373ab	2.5b
Alternating	400	600	14.7a	388a	2.6a

[1]Values in column not followed by same letter are different at $P<0.05$

Effect of farmyard manure and urban composts on aggregate stability in a loamy soil.

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Intensive agriculture is known to cause a decline in soil organic matter content (SOM) and alter soil structure leading to an increased risk of soil erosion. Indeed, in loamy soils under temperate climate, SOM is an important factor responsible for aggregate stability. In many soils of Ile-de-France area, organic wastes such as livestock effluents or composts should be used to counteract the decrease of SOM.

The objective of this study was to compare the effect of organic amendment application (farmyard manure, FYM; municipal solid waste composts, MSW; biowaste compost, BW) on aggregate stability in a loamy soil under field condition. Laboratory incubations of mixtures of calibrated aggregates (millimeter scale) with the same organic amendments were realized in controlled conditions to explain the effects observed in field conditions. The evolution of aggregate stability was followed throughout the incubation period under two temperature scenarios (28 and 4 °C). The effects of organic treatments were related to their biodegradability use as indicator of the microbial activity generated after compost addition and to the initial characteristics of the added organic matter (C/N ratio, humic substances and biochemical fractionation). The aggregate stability was measured by using the water test of Le Bissonnais[1] method.

Initially, the soil was characterized by an unstable structure. After one application of the different organic treatments, aggregate stability increased in the MSW and BW-treated plots as compared to the control plot. In laboratory conditions, MSW-compost and FYM enhanced the aggregate stability, more at 4°C than at 28°C. Both results (field and lab conditions) were related to the stimulation of microbial activity after addition of still highly biodegradable organic amendments, more persistent at 4°C than at 28°C. However, the effects of highly biodegradable amendments are expected to be more transitory than in the case of stable composts, more efficient in increasing SOM.

[1] Le Bissonnais, Y.1996. Aggregate stability and assessment of soil crustability and erodibility. I. Theory and methodology. European Journal of Soil Science, 47, 425-437.

Short term evolution of pig slurry macronutrients (N, P, K) accumulated into an over amended lysimeter (SOLEPUR)

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A 3280 m^2 lysimeter in integral drainage (SOLEPUR) received during 5 consecutive years massive organic fertiliser amounts in the form of pig slurry at a rate of 1000 $m^3.ha^{-1}.an^{-1}$. During that time, more than 24 $t.ha^{-1}$ of total nitrogen, 8 $t.ha^{-1}$ of total phosphorus and 16 $t.ha^{-1}$ of total potassium were spread onto the experimental field. In five years, the total nitrogen concentrations of the top soil increased from 0.18 $gN.kg^{-1}$ to 0.35 $gN.kg^{-1}$ which increased the soil nitrogen stock by more than 4.5 $t.ha^{-1}$. Six years after the end of spreadings, a part of the accumulated nitrogen was mineralised, the total nitrogen content of the first horizon decreasing from 0.35 $gN.kg^{-1}$ to 0.28 $gN.kg^{-1}$. Mineralisation rates were strongest during the three first years after spreadings and decreased significantly the three following ones. Over six years, the mineralised nitrogen stock was estimated to be 2.6 $t.ha^{-1}$. During the same period, water flow rates and volumes draining from the lysimeter were monitored. Nitrogen leaching was measured at 1 $t.ha^{-1}$, or 170 $kg.ha^{-1}.yr^{-1}$ on average. For phosphorus, soil analyses highlighted an accumulation of more than 6.6 $t.ha^{-1}$ of extractable Dyer phosphorus during the loading period, which represents a recovery of more than 82 % of the phosphorus applied. A large part of phosphorus applied was recovered in the top surface layer (0-20 cm). After the applications were halted, the extractable Dyer phosphorus contents hinted a possible migration from the top soil layer down to the lower layers. No significant phosphorus concentrations in the drainage water were measured, which confirmed the strong phosphorus retention capacity of the soil. Potassium applied through pig slurry seemed to be equally distributed throughout the soil profile. Six years after the applications ceased, the amount of soil exchangeable potassium decreased, while potassium concentrations in drainage water did not follow the same trend and remained high.

Anaerobically Digested Source Separated Food Waste as Fertiliser in Cereal Production

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Field trials were carried out during 1999-2003 funded by Jönköping Municipality in southern Sweden, in order to evaluate the effect of anaerobically digested, source separated food waste originating from households as fertiliser in cereal production. Digestion is carried out in a plant where biogas and a digestion residue are produced. The aim of the trials was to study the effect of the fertiliser on crop yield, nutrient balances and grain quality in production of spring-sown cereals.

The field trial was designed as a split plot trial with 3 repetitions and 7 treatments in 1999, 2000 and 2003, as well as 8 treatments in 2001 and 2002. The digestion residues, with a dry matter content of 1-3 %, were compared to mineral fertiliser (all years) and slurry from dairy cattle (2001-2003). Two different spreading strategies were evaluated in 1999 and 2000; spreading at time of sowing as well as spreading when the crop was between 15 and 20 cm high. In 2002 and 2003 a treatment with concentrated digestion residues was included.

Results show that digested food waste is a fertiliser that can replace mineral fertiliser in cereal production, se table 1. The nutrient balances show a surplus of nitrogen for digested food waste as well as slurry, compared with mineral fertiliser. The nutrient balances also showed small deficits concerning phosphorus when using digested food waste as fertiliser.

Table 1. Yield of barley (1999, 2000, 2002) and oats (2001) in treatments with digested food waste compared to mineral fertiliser and slurry.

Year	Digested food waste, spring	Digested food waste, summer	Slurry	Conc. digested food waste
	Yield, % of yield with mineral fertiliser			
1999	99	95	--	--
2000	90	81	--	--
2001	105	--	110	80
2002	72	--	70	65
2003	81	--	73	--

Short-term carbon and nitrogen mineralisation in soil amended with winery and distillery organic wastes

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Wine production of Mediterranean countries represents ca. 60% of the entire world-wide production. Grape stalk and marc, wine lees and exhausted grape marc are the main by-products and wastes generated by wine and alcohol-producing industries. According to the Council Regulation (EC) nº 1493/1999 on the common organisation of the market in wine, grape marc and wine lees must be sent to alcohol distilleries, producing exhausted grape marc and a liquid waste (vinasse). However, the small wine-producing industries do not follow this law, generating grape marc and wine lees together with grape stalk as organic wastes. The main problem of all these organic materials is their disposal and treatment because of their seasonal character (great production during August-October), low pH and a high content of phytotoxic and antibacterial phenolic substances, which resist biological degradation. However, these organic wastes have also high organic matter and potassium contents and significant levels of nitrogen and phosphorus, important factors in soil fertility.

Nowadays, recycling of organic wastes in soil could be a way of disposal, thus, the addition of the winery and distillery organic wastes could result in a method for reducing disposal costs and recycling the organic matter and nutritive elements of these wastes in the soil-crop system. The aim of this work was to study the influence of organic materials derived from winery and distillery industry on the carbon and nitrogen mineralisation. The influence of soil type was also monitored.

Incubation experiments with three different calcareous soils (clay-loam, loam and sandy textured) mixed with four winery and distillery organic wastes such as grape stalk, grape marc, wine lees and exhausted grape marc (40 g organic material kg^{-1} soil (d.w.)) were made to monitor the organic C and N mineralisation of these materials during a 17 weeks incubation period by analysis of microbiological parameters (soil respiration and microbial biomass) and different forms of nitrogen produced by a non-leached procedure.

The addition of these materials in the soils produced a slight increase of the inorganic nitrogen, observing an inhibition in the N mineralisation in the soils amended with grape stalk. Organic matter mineralisation was probably influenced by soil type, the sandy soil favouring more than the clayey soil the N and C mineralisation processes. Also, a significant increase in the soil biological parameters was observed in the amended soils compared to the non-amended ones.

Differences in the chemical composition of colloidal organic matter from various municipal solid waste composts as studied by pyrolysis/GC/MS.

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Large quantities of organic amendments are applied to agricultural soils. A part of the added organic carbon is degraded and/or transformed by microbial activity within 4 to 5 weeks, while a small proportion may contribute to the Colloidal Organic Matter (COM), and be transferred down the soil profile. Knowledge of the nature, composition and reactivity of COM is still incomplete, leading to limited understanding of the possible impacts of COM on agricultural soils.

The objective of this work was to characterize by pyrolysis/gas chromatography/mass spectrometry (pyrolysis/GC/MS), the chemical composition of colloidal solutions extracted from soils and composts with an accelerated solvent extraction (ASE), at various temperatures.

We studied agricultural soils originating from a field experiment in France, which aims at comparing the effects of different compost types on soil properties. Two soils treated with different composts and a control soil were sampled, along with mature and immature composts.

The colloidal solutions were extracted and characterized by pyrolysis/GC/MS. A number of pyrolysis products were identified, some of them being specific of a macromolecular source. The COM extracted from the soils (treated and untreated) yielded very similar pyrolysates. The main pyrolysis products of the soil COM extracted at 20°C were N-containing compounds, with a minor contribution of polysaccharides. With increasing extraction temperature, relative amounts of polysaccharides-derived pyrolysis products increased. Polyphenol-derived products were observed in the pyrolysates of COM extracted from soils at temperatures higher than 125°C.

The pyrolysis of compost COM extracted at 20°C displayed mainly N-containing compounds. The distribution of pyrolysis products varied with the maturity of the compost. Pyrolysis indicated an important bacterial origin of the immature compost extract.

This study underlines the ability of pyrolysis for revealing differences in the organic compositions of COM extracted from soils and composts. These differences can be used to understand the specific reactivity of COM for organic pollutants present in soils.

Soil Fertility Building Crops in Organic Farming

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Introduction

To be sustainable, organic farming needs to be self-sufficient in N, through fixation of atmospheric N_2 by legumes, recycling of crop residues and the application of manures, or composts. Only fixed N represents a true import of N onto the farm. Despite this reliance on legume N, much remains to be understood about how to maximise N fixation and use it efficiently. The availability of soil mineral N is thought to reduce the capacity to fix N and soil N will be increased by manure applications, mulching, and grazing. The aim of this study is to establish the extent to which increased soil fertility adversely affects N fixation.

Materials and methods

Forty eight paired plots (1.5 x 10m), were cultivated either with, or without composted FYM in the seedbed in autumn 2002 and top-dressed with FYM in 2003. Half of the plots were sown with a red clover/perennial ryegrass mixture; the remainder with just perennial ryegrass.

Treatments

Six replicates of:

A. Red clover/ryegrass mixture (herbage cut and removed)

B. Ryegrass only (herbage cut and removed)

C. Red clover/ryegrass mixture (herbage cut and mulched)

D. Ryegrass only (herbage cut and removed, then mulched with herbage from **A**.)

Nitrogen accumulation is estimated in above-ground herbage and below-ground in soil mineral N and macro organic matter N. Fixation is estimated by subtracting the grass controls (**B** & **D**) from the treatments with red clover (**A** & **C**). Legume crops from six commercial organic farms are also being assessed to compare with the plot data.

Conclusions

N fixation has not yet been suppressed by the addition of FYM, or by mulching. This may be due to the low availability of N in composted manure and mulching may require another season to build up soil fertility levels significantly. Data for 2002/3 will be presented.

PH and Nutrient Content in Sewage Sludge Treated with Limestone By-Products for Agricultural Use

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The elimination of the sewage sludge produced in Waste Water Treatment Plants (WWTP) is a rising concern. In view of the interesting characteristics of the sewage sludge as the organic matter and nutrient contents (especially nitrogen), its utilization in agricultural and forest lands has been suggested. However, a continuous use of these residues can lead to soil acidification and increase the heavy metals concentrations and pathogen microorganisms populations. The treatment of sewage sludge with limestone by-products is proposed as an alternative to minimize these risks. Therefore, the resulting mixture has a more suitable pH, the heavy metals are in unlikely available forms and the pathogens populations are drastically reduced. The evolution of pH and nutrient content of several sewage sludge treated with lime and dolomite at different doses is studied in this work, as an attempt to determine the more appropriate sludge-liming ratio. Looking at the results, the most appropriate dose seems to be the one having 30 % of the liming agent on the weight of the sludge dried.

Evolution of the Nitrogen Apparent Recovery Index of Total Nitrogen of Solid Manure Applied Every Year on a Cut Perennial Rye Grass

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After spreading, an important fraction of nitrogen solid manure meets the nitrogen stack of soil organic matter. Regular applications of solid manure must, therefore, lead to a progressive increase of nitrogen apparent recovery (NAR) indexes of total nitrogen of these solid manure. Indeed, receiving grassland will gain nitrogen not only from solid manure applied at the start of every campaign but also by an extra mineralisation of the nitrogen stack of the soil organic matter.

A permanent trial has been settled by 1996 on the experimental station of La Jaillière (44) located in the region Pays de la Loire (West of France). This experimentation has allowed us to appraise the evolution of NAR indexes of four solid manure : cattle stored solid manure, cattle composted solid manure, stored broiler litter and composted broiler litter. Solid manure have been applied on a cut perennial rye grass every year in autumn. Solid manure rates have been calculated so that the annual average amount of total nitrogen brought to the perennial rye grass is equal to 200 kg N/ha.

The NAR indexes of total nitrogen of studied solid manure have been calculated year to year with the data registered in the trial from 1996 to 2003. None significant increase of these indexes has been observed during the first eight years of the trial. Hence, the mean values of the NAR indexes can be considered as an assessment of the direct nitrogen effect of each type of used solid manure. The average NAR indexes found for the perennial rye grass were : 0.12 with the cattle stocked solid manure, 0.11 with the composted cattle solid manure, 0.30 with the stocked broiler litter and 0.21 with the composted broiler litter.

Effect of the nitrification inhibitor DMPP applied with mineral fertiliser and cattle slurry on yield and N uptake from grassland

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Nitrogen affects plant yield and quality like no other plant nutrient, but its excessive application by farmers may have unwanted effects on the environment. From an ecological viewpoint, using a nitrification inhibitor (NI) with ammonium based fertilisers may be a potential management strategy to lower the production of nitrate, thus decreasing their undesirable effects. Since nitrate is the major source of the environmental problems related to soil N dynamics (nitrate leaching, denitrification) and nitrate comes from nitrification certain NI´s are of interest for being highly effective. This is specially so in grasslands of the Basque Country, where it has been found that most of the fertiliser N applied to soils is oxidised quite rapidly to nitrate by nitrifying microorganisms (Merino *et al*., 2002). The aim of the present study was to assess the effect of DMPP on forage production and N uptake from slurry applications in comparison to mineral ones in grassland systems of the Basque Country. Two kinds of fertilisers were applied: mineral (M) as ammonium sulphate nitrate 26% (19.5% ammoniacal and 6.5% nitric) and cattle slurry (S). DMPP (1 kg ha^{-1}) was used or not with both types of fertiliser. Following each fertiliser application grassland yield was assessed. Grass was dried in a forced-air oven at 70ºC for at least 48 h, weighed, and then ground. Nitrogen concentrations were performed on dried and ground herbage using a Macro Kjeldahl method.

Table 1. Total yield, N uptake and percentages of clover, ryegrass and other species with fertiliser with and without DMPP and an unfertilized treatment (Control).

Treatment	kg DM ha^{-1}	% N	Kg N ha^{-1}	Clover (%)	Ryegrass (%)	Other species (%)
C	5661 b	2.9 c	153.5c	17.1a	58.5 b	24.3 a
M	6804 ab	3.3 b	225.2 b	3.9 b	79.6 a	19.5 a
M+DMPP	8764 a	3.5 a	306 a	3.2 b	70.7 ab	25.3 a

No significant effect of DMPP was observed on slurry fertilisation, while in mineral fertilisation, the use of DMPP did significantly increase biomass yield and N uptake.

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Application of wood ash originating from the timber industry as a soil amendment in an experimental pasture under intensive management

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The cost involved in the storage and disposal of the large quantities of wood ash generated by the timber industry has raised interest in the search for alternative management techniques. Use of the wood ash to correct acidity and to fertilize agricultural land are amongst the possible alternatives being considered. Certain characteristics of the wood ash, such as its high nutrient content, strong alkalinity and low levels of heavy metals make it potentially useful as a soil amendment in acid soils.

The aim of the present study was find out the effect of the application of wood ash to mixed pasture land subjected to intensive management and on which slurry and nitrogen-based fertilizers were used, as well as to evaluate potential problems derived from the application of the different fertilizers and possible overfertilization.

For quantification and evaluation of the usefulness of wood ash as a soil amendment in comparison with lime and other fertilizers we selected a field under pasture, in Lugo (Spain). The field was part of agricultural land and the soil was considered to be fertile. Five different treatments were incorporated when the grass was sown at a depth of 20 cm: 1) control treatment; 2) 3 Mg $ha^{-1}$of lime and 80 kg $ha^{-1}$of P_2O_5; 3) 6 Mg $ha^{-1}$of wood ash and 80 kg $ha^{-1}$of P_2O_5; 4) 10Mg ha^{-1} of wood ash; and 5) 10 Mg ha^{-1} of wood ash and 80 kg $ha^{-1}$of P_2O_5. The experimental design consisted of 20 plots with 4 replicates per treatment.

The results showed no significant differences among the treatments in terms of parameters related to nutritional status and production of the pasture. This may have been because the soil in the field was already fertile. As regards potential contamination by heavy metals in the wood ash, there was no difference in the concentrations of these elements in treated and control plots. Use of this type of wood ash could be justified as a possible alternative to traditional amendments and mineral fertilizers, thereby reducing the costs associated with the land use.

Laser granulometry of colloidal organic matter extracted from composts

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Soluble organic matter from composts is a transitory fraction that could play an important role when composts are applied to the soil. Particularly, it is mobile into the soil profile and becomes a potential vector of pollutants. This fraction is mainly colloidal and the reactivity depends on the colloid size and their surface charge distribution. The objective of this work was to characterize the size of the colloids extracted from composts and compost amended soils using laser granulometry based on LALLS (Low angle laser light scattering) principle. This technique allows to measure size distributions of particle diameters >0.040 µm.

A composts of sludge and green waste was used, sampled during the fermentation phase (FC) and after 6 months of maturation (MC). Amended (AS) and non amended soils (NS) came from an experimental field at Feucherolles, near Paris. The colloid matter were extracted from soils (AS and NS) and from composts (FC and MC) by shaking in water at 20°C and by pressurised water at different temperatures (50, 125 and 175°C) using an "accelerated solvent extractor" (ASE, Dionex) allowing to maintain water at a liquid state under subcritic conditions. The organic C content and the colloidal size distribution of the extracts were measured.

The water extracts at 20°C of composts were characterized by a particle-size distribution from 0.040 µm to 0.800 µm, with modes at 0.170 µm and 0.120 µm for the FC and the MC respectively. The increase of the extraction temperature allowed an increase on the extraction yields in soluble organic matter. The range of colloid diameters in hot water extracts was between 0 and 0.200 µm. The equivalent diameter of colloids decreased when the temperature extraction increased; the modes were 0.067 and 0.055 µm for extracts at 125 and 175°C respectively.

The particle size distributions of soil water extracts ranged from 0.040 to 0.300 µm, with modes at 0.067 and 0.073 µm and were independent of the extraction temperatures.

When the colloidal extracts from compost were adsorbed to the soil, a selection of colloids was done. The non adsorbed colloids, remaining in solution, was selected in relation to their size and reactivity against the soil surfaces. The selection of compost colloids during soil sorption depends on the temperature of extraction indicating that the nature of extracts depends on the subcritical conditions of the water used.

Assessing N dynamics of organic wastes in field conditions using a calculation model

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To limit environmental impacts, it is necessary to get better knowledge on the behaviour of wastes after spreading onto soil (i.e. N mineralisation dynamics) to provide more accurate recommendations and guidelines for farmers. For this purpose, we characterised N release of sewage sludges (SS) and untreated waste waters (WW) from food-processing industries in field conditions.

In this 18 month field trial, 7 treatments (3 replicates) were considered: control soil without spreading and soil after spreading with six different wastes. All plots were maintained as bare fallow during the whole experiment. Soil cores were sampled every 2-3 weeks to 120 cm depth (divided in 4 equal layers), moisture and inorganic N (NH_4^+ and NO_3^-) contents being determined in soil for each layer. Meteorological data were collected automatically every day. The daily values of water evaporation and drainage, N mineralisation and leaching were calculated using the measured data and the capacity-type model LIXIM (Mary et al., 1999). N Mineralised and N leached due to waste application was calculated as the difference between the amended and control soils.

Analyses and field trial results confirmed the diversity of the wastes (Table 1). The C:N ratios varied from 5.3 to 21.2. LIXIM was able to reproduce satisfactorily the water and inorganic N contents measured in all treatments (not shown). The wastes also induced very different N mineralisation rates and dynamics. The results justify the growth of catch crops when these wastes are spread in summer or autumn. WW n° 4 did not contain inorganic N and did not release N, thus it induced less leaching than the control soil. Waste n° 3 caused no leaching during the first winter, but it did in the following year, due to net N mineralisation during this period (results not shown).

Table 1. Amounts of applied N, N mineralisation rates and N leaching following spreading.

	Organic N applied	NH_4^+-N applied	Organic C:N ratio	Waste N mineralised			N leached		
	kg N ha^{-1}	*kg N ha^{-1}*		*% of added organic N*			*% of added total N*		
Days after spreading				*29*	*85*	*374*	*29*	*85*	*374*
1. Alfalfa dehydrating WW	42	36	13.4	-74	-55	-49	0	0	+29
2. Liquid distillery SS	117	38	5.3	+4	+28	38	0	-6	+29
3. Distillery WW	141	2	15.5	-3	+8	+26	0	-3	+3
4. Sugar refinery WW	230	0	21.2	-4	-3	-2	0	+1	-6
5. Solid distillery SS	52	21	7.4	0	+60	+58	0	-13	+39
6. Municipal SS	113	20	14.6	-2	+15	+46	0	-2	+24

Nutrient load from agricultural source in Lombardy (Italy)

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The Lombardy region of Italy is characterized, from the agricultural point of view, by high intensity of production and concentration of crops and livestock, mainly in the plains area. To improve the knowledge of potential impact of agricultural activities on environment, an assessment on loads of nutrients (nitrogen and phosphorus) deriving from agricultural practices has been carried out.

The evaluation is based on a mass balance of inputs and outputs at field level and considering phosphorous and nitrogen as potentially polluting nutrients. The inputs are therefore chemical and organic fertilisers; the outputs are the crop uptakes.

The data used in defining the amount of nutrient used in agriculture derive from the information related to livestock units and from the amount of chemical fertilisers generally utilised for the crops practiced. The crop uptakes have been based on the average crop yield and on the amount of nutrients contained in the products removed from the field. Data have been organised in a database in order to process them and to connect then to spatial information by using a GIS (Arcview – ESRI).

The results obtained have pointed out as the more risky area are, as expected, those where there is a high livestock intensity, but with high variability according to the cropping system used and to the pedo-climatic conditions of the area. Anyway, nutrient surplus are in some area over 200 kg of nitrogen per hectare and 300 kg of phosphorus per hectare. Therefore it can be emphasised that there is a short term impact due to the high mobility of nitrogen while the phosphorous excess does not have an immediate impact but the consequent build up in soil might cause an increase of Phosphorus release in surface and even in ground water under special circumstances.

Keywords: Diffuse pollution, manure management, nutrient balance

A field device for slurry nutrient content assessment

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Agricultural slurries contain useful amounts of the plant nutrients. However, the quantity of these nutrients available in a particular slurry is not easy to quantify without laboratory facilities. Thus, when agricultural slurries are applied to land, their fertilizer potential is often unknown and the supply of the crop requirements and the environment safeguard are not guaranteed.

In order to achieve the goal to make better use of slurry and to reduce pollution risks, convenient methods and means are necessary to quantify the nutrients and to spread them efficiently and accurately in accordance with codes of good agricultural practice.

For that reason, based on the positive results of previous experiences, a device for indirect measurement of nutrient content of slurry has been developed.

The prototype developed has been tested on manure samples collected from farms with different livestock typologies (manure removal and species). A comparison between the measurements obtained with the sensor and the lab analyses has been carried out.

The device is able to process the electrical signal of a probe inserted in the slurry in order to show directly the nutrient content of the manure and to record in a memory card the values on a programmed time step. The equipment can be inserted on slurry tanks or next to the slurry storages.

The results of tests carried out have shown the significance of the correlation between the nutrient content of slurry (especially nitrogen) and its electrical properties measured by the device.

Furthermore, the tests executed with the device installed on the slurry tanker have showed a good stability of the measures during and after the load.

Thus, the device developed seems to be a valid support for a better agronomic use of slurry by giving to farmers low cost and direct indications of nutrient content of the slurry.

Keywords: nutrient content, slurry, measurement

Wood-bark ash fertilization in a plantation of *Pseudotsuga menziesii*: Effects on nutritional status, tree growth and biomass production.

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The timber industry generates large quantities of wood ash during the combustion of wood remains, principally wood bark. The wood ash is considered as a "non hazardous" product (Ministry of Environment, 2002), and in Galicia an estimated 40.000 to 50.000 t is produced every year (pers. comm., Asociación Galega Monte-Industria). As an alternative to disposing of the wood ash in landfill sites, its application to agricultural land and forests is a promising method of revaluing this waste product.

Plantations of *Pseudotsuga menziesii* are grown in rotations of 60 years and its exploitation involves the extraction of significant amounts of nutrients from the ecosystem. In combination with the use of intensive silvicultural practices and the lack of fertilizing regimes, this causes impoverishment of forest land and leads to significant nutrient deficiencies in the stands. The poor nutritional status of *Pseudotsuga menziesii* in northwest Spain has led to investigation of the problem with the aim of improving the nutritional status of the stands, which particularly lack nutrients such as P, K and Mg. Wood ash originating from the timber industry is a possible alternative to mineral fertilizers because of its high nutrient content, its neutralizing capability and its low heavy metal content.

The aim of the present study was to evaluate the effects of the application of wood-bark ash on soil chemistry, soil solution, nutrient foliar concentrations and tree growth throughout three years. For this, a six year-old plantation was selected. The soil under the plantation was acidic (pH 4.6), rich in organic matter (12.4 %) and contained low levels of available P, Ca and Mg (6.9 mg kg^{-1}, 88.9 mg kg^{-1} and 10.9 mg kg^{-1}, respectively). Two different doses of ash (10.000 and 20.000 kg ha^{-1}) were applied to different plots. For the experiment 12 plots were used, with 4 replicates per treatment in a randomized design.

Fertilization of the soil with industrial wood ash led to an increase in soil pH, at the same time increasing the availability of Ca, Mg and K. The concentrations of heavy metals were always low and were not modified by application of the wood-bark ash. Application of wood-bark ash led to higher biomass production and growth of the trees than in the control plots, and also improved the nutritional status, mainly in terms of K.

Moisture characteristics of rice husk as the artificial media and demonstration by sweet potato cultivation

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The amount of the rice husk produced as the agricultural residue would reach 2 million ton in 2000. The rice husk has been managed for abandonment, bedding, manure, underdrain, mulching and culture medium in large order. It is necessary to develop the effective usage for the agricultural resource instead of the abandonment of the rice husk which causes a serious problem. In this research, rice husk was examined on the characteristics of moisture as the new culture media and on the adaptability to the sweet potato growing. The moisture characteristics, such as water retentivity, water conductivity and available moisture, were determined by the centrifugal method and the suction one.

Table 1. Indices of water retentivity, water conductivity and available moisture

Sample	water retentivity Θ (cm^3/cm^3)	water conductivity K (cm/day)	available moisture %
Rice husk	0.0142	0.0016	3.5
Crushed rice husk	0.0250	0.0052	5.0
Rice husk charcoal	0.0642	0.0136	11.5
50% rice husk + 50% rice husk charcoal	0.0571	0.0106	8.5
Masa soil (control)	0.0790	0.0225	17.0

Each moisture characteristic of 100% rice husk was the lowest of all as shown in Table 1. As the values of Θ and K greatly influence the water-supplying-power to plant roots, the power of 100% rice husk was indicated to be small. Several kinds of cultivation bed filled with different types of the rice husk or Masa soil were prepared, and sweet potato was grown in each bed for 142 days. The root growing in the culture media of 100% rice husk penetrated into the soil remarkably through the rice husk bed to supplement water deficit. Sweet potato vigorously grew during the cultivation period, therefore it was obtained the rice husk was useful as a good culture medium.

Application of wood ash in forest soils in Northern Spain developed on different parent materials.

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The wood ash produced in bioenergy plants associated with timber industries in Europe is considered as a "non hazardous" product and is usually confined in landfills. However, because of the high concentrations of nutrients and low levels of heavy metals in the wood ash, its application to forest soils can improve environmental management and also the nutritional status of the plantations. This method of fertilization can also provide a way of restoring nutrients exported as a consequence of biomass removal at harvesting. Most of the *Pinus radiata* D. Don plantations in Northern Spain are deficient in P, Mg and Ca, a finding that is attributed to the strong acidity of the soils as well as to the large amounts of nutrients removed as a result of the short rotations used (less than 40 years). The objective of this study was to develop a system of improving the environmental management of the wood ash residue and at the same time improving the nutritional status of forest plantations.

In the study wood ash was applied to six *Pinus radiata* D. Don plantations of different ages (5, 15 and 30 years) and developed on different type of soils (developed quartzite, serpentinite and clay sediments). The study focused on monitoring the response of the soils and soil solutions throughout the first 18 months following application of the wood ash. For this, monitoring was carried out in a total of 50 untreated plots (35 x 35 m), 50 plots in which 10 Mg ha-1 of wood ash was applied and 12 plots in which P fertilization (100 kg of P partially attac ked type 0-29-0) was carried out following application of wood ash.

The results showed that the response depended on the type of soil. Throughout the 18 months of the study the pH of the soil tended to increase in most plots and available Ca and Mg also increased. In some cases, however, the pH of the soil solution decreased, coinciding with higher levels of NO_3^-, suggesting an enhancement of soil nitrification processes. The concentrations of heavy metals were no different to those in the untreated plots.

Investigations on the fertilizing capacity of bottom sediments from eutrophicated lake

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The Srebarna Biosphere Reserve is among the well known protected territories not only in Bulgaria. Its broad popularity is due to the exclusive biodiversity which this relatively small Danubian lake contains.

The biggest problem of the reserve is increasing eutrophication and low water level. Lake eutrophication includes increased input of nutrients and the increased CO_2 fixation in the lake ecosystem. In case of unbalance of organic matter decay and low output of products, accumulation of rich of organic matter sediments is observed.

The main sources for nutrients are out of the lakes (rivers, soil erosion, etc.), but rich of organic matter sediments are an important source for the lake's waters eutrophication, too. A way for decreasing lake eutrophication is the partially scraping up of the lake sediments. Sediments could be used as fertilisers in nearest fields.

Incubation experiment with sediments rich of organic mater showed increasing rate of the nitrogen mineralization in studied soil.

Application of isotopic exchange kinetic method for assessment of phosphorus availability in sediments is a rarely used in such type of study. But this method is very useful of the assessment of P availability in sediments.

Table 1 . Assessment of content N and P content in bottom sediments from lake "Srebarna" (tons)

	N tot	P tot	Isotopically exchangeable P		
			for 1 day	between 1 day and 3 months	for more than 3 months
Total content	3300	270	6	18	246
Annual rate of accumulation	65	5	0.12	0.36	4.92

Our investigation in Srebarna area shows that N and P content in some of soils and sediments is hazardous for lake water eutrophication. Sediment organic matter is a good organic fertilizer for the nearest eroded soils.

Fertilization of Barley with Pig Slurry: Residual and Cumulative Effects

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Pig slurry is commonly utilized in agriculture as a source of nutrients for crops; however, this way of waste recycling is not without environmental risks. The aim of this study was to assess the effectiveness of pig slurry amendment on barley yield and mineral composition.

Five doses of pig slurry (30, 60, 90, 120 and 150 m^3ha^{-1}) were applied to a barley crop experiment situated in the experimental farm "La Higueruela" (Santa Olalla, Toledo). The area was divided into two sets of plots; one of them received pig slurry once at the beginning of the experiment in order to study the residual effects after five years, and the other set has been amended annually (cumulative effects). All treatments were compared with a mineral fertilization (MF) and a control plot. Crop yield and nitrogen, phosphorus, potassium, copper and zinc content (both in grain and straw) were measured.

Pig slurry addition had a positive effect on total dry matter, since the yield obtained with the cumulative additions of 120 and 150 m^3ha^{-1} were significantly higher than control and MF. The highest grain yield was observed in the plots treated with 150 m^3ha^{-1}; however, there were not significant differences among the treatments. On the contrary, total and grain yield in the residual plots were similar or lower than the control and MF plots.

Macro and micronutrients in both grain and straw were very similar in all residual plots with the exception of phosphorus and potassium, which decreased in grain with the increase of the dose of slurry. In cumulative treatments, nitrogen was the most affected nutrient by pig slurry addition, so the higher the dose, the greater the nitrogen content was, both in grain and straw. With respect to the content of copper and zinc, there were not problems of contamination by heavy metals accumulation.

C, N, and P content in soil following pig-slurry application to crop rotations with different input levels

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The supply of animal wastes to agricultural soils may contribute to the improvement of soil fertility as well as to soil C sequestration. The quantification of these effects is essential to accurately predict the consequences of crop manuring on both crop productivity and environmental quality. A multi-year experiment was started in 1993, the aim being to evaluate the suitability of selected cropping systems to receive pig slurry applications, whilst limiting the negative effects on the environment. In the present study we focus our attention on changes in soil C, N, and P content at cropping systems level.

The experimental site is located in the lower Po Valley, Northern Italy, on a silty clay soil. Each rotation is conducted with three different sets of agronomic inputs (including tillage, pig slurry, and mineral fertilisation), corresponding to three different production orientations (traditional, reduced and minimal). The traditional-input (T) plots receive both pig slurry and chemical fertilisers. The reduced-input (R) plots receive pig slurry and a lower amount of chemical fertilisers than the T plots. In the minimal-input plots (M), crops are supplied with low amounts of chemical fertilisers. Organic C, total N, clay-fixed ammonium N, total and Olsen P were measured on samples collected in winter 2000-2001, under crops belonging to the sugar beet–sorghum–winter wheat (BeSrW) and soybean–winter barley + sorghum second crop (SyBa+SrII) rotations.

The T and R plots showed a higher C, N and P content than the M plots (Tab. 1). The input effect was more evident for the BeSrW rotation than for the SyBa+SrII rotation. Minor differences were detected on the whole between the T and the R plots. The observed differences were mainly attributable to the Olsen- and total-P content.

Table 1. Soil average content of selected fertility components in the top 1.2-m soil profile of two crop rotations, 7 years after the starting of the experiment. The soil C, N, and P content in the traditional- and reduced-input plots is expressed as percentage of that in the minimal-input plots.

Fertility component	BeSrW		SyBa+SrII	
	Traditional	Reduced	Traditional	Reduced
Organic C	117	114	102	106
Total N	132	122	108	113
Fixed NH_4^+-N	119	117	102	104
Total P	151	120	118	116
Olsen P	416	207	224	124

We conclude that the effect on soil fertility of repeated pig slurry applications may depend on the type of crop rotation.

Utilization of Tannery Waste as Soil Less Media in Agriculture

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Tannery industries create serious environmental problems especially in terms of polluting organic effluent and the hazardous solid wastes as a result of hides and skin processing. Tannery waste is catagorised as toxic and hazardous waste in Malaysia due to the high content of Cr (in excess of 500 ppm) and other heavy metals. It is utmost import that the tannery waste in the form of waste sludge and shavings are managed in an environmentally sound manner.

A study was carried out to investigate the potential utilization of tannery sludge and shaving in agriculture by using the wastes as soil less media for growing tomatoes. Germination tests were carried out using different media ratio which is described in the paper. The results showed that there was a significant difference between initial and final growth medium in terms of pH, EC, root to shoot ratio, plant height and leaf area. Seed germination was inhibited at 5 days due to high Cr level but significantly increased after 14 days of sowing. It was concluded that 50% and 25% waste media provide more appropriate soil less media for plant growth compared to pots with 100% and 75% sludge content. The potential use of tannery sludge and shavings in agriculture appears to be feasible as long as the correct application of waste to soil ratio is maintained.

Prediction of nitrogen mineralisation from organic residues applied to ryegrass and wheat crops

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The increased production of organic residues derived from different sources, made it urgent to find an environmentally safe alternative use. These residues can be recycled to agricultural land as a source of both organic matter and nutrients namely nitrogen (N). This will contribute to the effective utilisation of these on- and off-farm waste materials as valuable resources in agricultural rotations to enhance sustainability and economic competitiveness. To assess the potentially mineralisable N from six organic residues, a laboratory aerobic incubation was carried out on a Cambic Arenosol for 244 days. Incubations consisted of 6 treatments corresponding to: 0, 40, 80, 120, 160 or 200 kg N/ha The 2 *M* KCl extractable N fraction was determined at 9 sampling times to determine mineral N evolution. Two pot experiments with ryegrass (*Lollium perenne* L.) and wheat (*Triticum aestivum* L) were performed in the same soil to test the reliability of N fate predicted by incubation experiments. In the pot experiments, only 80 and 160 kg N/ha treatments were tested, with or without mineral N fertilisation.

Table 1. Some characteristics of the residues applied (municipal solid waste M, pulp-mill sludge S, horn meal H, poultry manure P, solid phase from pig slurry SP and composted pig manure C.

	M	**S**	**H**	**P**	**SP**	**C**
Kj-N (g kg^{-1})	17.80	42.40	116.70	35.50	17.40	21.70
C/N	15.70	12.65	4.20	12.51	23.80	21.70

Results from the incubation experiments were very well adapted to the one pool kinetic model proposed by Stanford and Smith, resulting in good fittings of the data. Since this model was originally developed for SOM mineralisation prediction, it showed a better fitting for the residues with a higher proportion of N recalcitrant compounds. Values of N_0 from the equations obtained by model fitting were well correlated to plant N uptake by ryegrass and wheat. Poultry manure was the most efficient N supplier to crops, since it presents a larger fraction of labile N than the other organic residues used. The joint application of mineral fertiliser and organic residues seems to be the best solution for plant nutrition.

Effects of 15 years use of sewage sludge on the plant-soil system

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The utilisation of sewage sludge (SS) in agriculture is regulated by national laws based, in Europe, on the 86/278 EEC Directive. However, doubts on the efficacy of the imposed limits still exist, particularly regarding contaminants such as heavy metals. Long term research on SS reuse on cropland are useful because many of the effects evolve slowly and are difficult to predict.

Since 1988 the effects of 16 different treatments with SS and/or mineral fertilisers have been evaluated on a winter wheat – maize – sugar beet rotation conducted on a silty-loam soil in the eastern Po Valley (Italy). Municipal-industrial wastewater sludge has been applied every year in autumn, as anaerobically digested slurry, dewatered cake and compost at two rates: 5 and 10 t DM ha^{-1} yr^{-1}.

Crop yields were evaluated each year. SS applied at a correct rate gave crop yields similar to the best mineral dressing and no evident phytotoxic effects.

We are analysing soil and crop products sampled in autumn 2003, to evaluate their nutrient and heavy metals contents. The results will be discussed in this paper.

Results obtained three years ago highlighted, for SS treatments, significant increase of organic matter, total nitrogen, available phosphorus, copper and zinc concentration in soil, in comparison with mineral dressing (Table 1, Figure 1). Other toxic heavy metals (Cd, Cr, Ni, Pb) were almost unaffected: only cadmium was slightly increased at the heaviest sludge rate. SS applications significantly increased the content of N, P, Zn and Cu in wheat grain, N and Cu in sugar beet roots, and only Cu in maize grain.

The major concern regards the increased availability of phosphorus in soil, for water eutrophication risk, and the build up of zinc, due to its role in controlling other heavy metals availability. Copper build up seems to be less problematic.

Composting as a management alternative for beef feedlot manure in southern Alberta, Canada

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Composting is gaining increased acceptance as a management alternative for the large volumes of manure produced by southern Alberta's beef cattle feedlots. Early studies at the Lethbridge Resarch Centre looked at the feasibility of summer and winter composting. Nutrient dynamics during composting, especially, nitrogen (N), phosphorus and carbon (C), has also been examined for straw- and wood chip-bedded manure. Greenhouse gas emissions have been measured on compost windrows. Additionally, we have looked at using compost in the reclamation of oil and natural gas wellsites where indigenous topsoil is in short supply.

Winter composting is feasible in southern Alberta even though ambient air temperatures may fall to -40 ºC. On average, N losses during composting were 22-36% and C losses 41-51%. GHG emissions measurements showed that roughly 95% of C loss was in the form of CO_2 with ~5% as methane (CH_4). For N losses, ~5% was emitted as nitrous oxide (N_2O) with the remainder (~95%) as ammonia (NH_3).

In a land application scenario, the amount of C added to soil for four forms of organic amendment is shown in Table 1. Although compost supplied lower amounts of C than manure for both straw and wood chip-bedded material, less of the applied C was mineralized, resulting in higher amounts retained by the soil. So in terms of storing C in soil, amendments were of the order: wood chip-bedded compost > wood-chip bedded manure > straw-bedded compost > straw-bedded manure.

Table 1. Land application of carbon per 1000 kg dry matter in the form of straw and wood chip-bedded raw manure and compost.

Bedding	Form	Total C conc. kg Mg^{-1}	C applied, kg	C mineralized, %*	C retained, kg
Straw	Manure	30.5	305	46.6	163
	Compost	21.1	211	6.4	197
Wood	Manure	39.6	396	32.5	267
	Compost	33.9	339	9.2	308

*Based on laboratory incubation study.

Compost was able to compensate for topsoil in wellsite reclamation. Over a 4 yr study, a one time application of compost with only 50% of topsoil replacement yielded an average of 9% higher than 100% topsoil replacement with no amendment.

Agronomic effects of different compost types, preliminary evaluations

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In Italy the annual production of compost is 1.360.604 t (Wastes Report, ONR ANPA July 2001). It can represent an important source of organic carbon and other phytonutrients (i.e. nitrogen) for the agricultural soil, therefore it is necessary to improve the knowledge of this matter management for its agronomic valorisation.

Aims: this experiment was designed to characterize the agronomic properties of three different kinds of compost used as organic fertilizer in agriculture. The object of this work is mainly the capacity to satisfy the nitrogen potato demand.

Materials and Methods: a plot experiment began in April 2003 at the Experimental Farm of the Faculty of Agricultural Sciences, Padova University. It was conduced in 48 lisimeters (2x2m sided). The experiment was a factorial combination of three types of organic matter used as organic fertilizer (supplying 200 kg/ha of nitrogen), a reference treatment (0 N), two types of irrigation (rainfed and irrigated at Etm) and 6 replications. The supply of K and P was increased to 200 units with mineral fertilization in all plots. The plots were cultivated with potato followed by Lolium multiflorum as cover crop. The three types of organic matter were: OM1 = compost coming from food processing industry residues (moderate C/N = 13.4, N% = 2.2, K_2O = 2.2 %, P_2O_5 = 1.3 %); OM2 = compost coming from green cuttings residues and organic fraction of the urban waste solid residues (moderate C/N = 15.3, N% = 1.65, K_2O = 6 %, P_2O_5 = 2.5 %)**;** OM3 = compost coming from composted urban waste and green cuttings residues (high C/N = 17.34, N% = 1.58, K_2O = 1.33 %, P_2O_5 = 0.598 %).

Results and conclusion

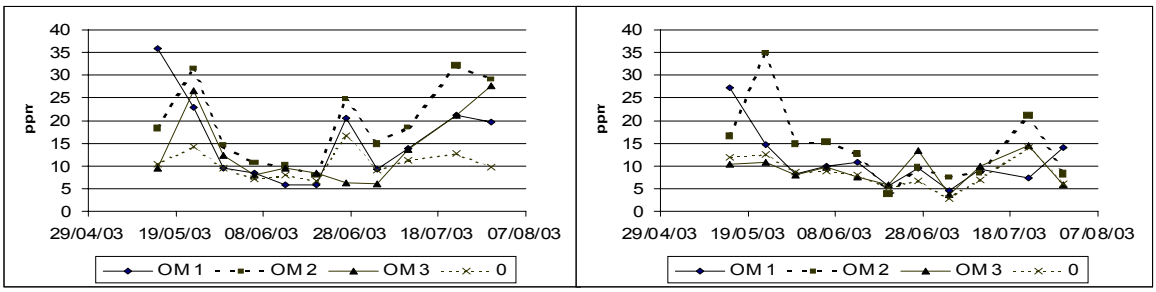

Fig 1: NO_3-N soil's concentration at two layers, 0-20 and 20-50 cm, during potato cycle in rainfed plots

There was a first mineralization peak after potato sowing and a second for OM1 and OM2 only, at the end of June 2003. These second was evident only in the 0-20 layer. The three organic matters seemed to have similar rhythm of mineralization but different oxidative stability. The OM1 released NO_3-N faster then the other two that gave similar results.

Evaluation of a compost obtained from solid phase of pig slurry and forestry wastes as a substrate for seedlings production

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The need to recycle wastes and the increasing environmental pressures against peat extraction has lead to an increasing interest on the feasibility of substituting peat by organic wastes composted. Compost obtained from a mixture of solid phase of pig slurry and forestry wastes was evaluated as a substrate component for the production of tomato and lettuce seedlings.

Four different substrates were tested: peat based substrate (control), compost (100C), a mixture of 50% compost and 50% peat substrate (50C) and a mixture of 75% compost and 25% peat substrate (75C). Physical and chemical properties of the substrates were determined. Seedling, in cells-trays filled with the four substrates, was performed in May 2003. Lettuce plants were harvested after 5 weeks and tomato plants after 6 weeks. The effect of the four substrates on germination, growth (table 1) and mineral composition of the plants of both species was evaluated.

Table 1. .Dry weight of shoots and roots of 21 seedlings

Substrate	Dry weight of lettuce shoots (g)	Dry weight of lettuce roots (g)	Dry weight of tomato shoots (g)	Dry weight of tomato shoots (g)
control	2.98a	1.38a	2.15b	0.80c
50C	2.78a	1.45a	3.15a	1,20b
75C	2.40a	1.33a	3.08a	1,25b
100C	2.83a	1.35a	3.53a	1,40a

In each column, means followed by the same letter are not significantly different $p \leq 0.05$.

Increasing the percentage of the compost on the substrate led to an increase of the pH values from 6.3 (control) to 6.9 (100C). However no significant differences were found for the electrical conductivity, indicating that for this compost no salinity problems are expected.

Moreover, results show that the compost obtained from a mixture of solid phase of pig slurry and forestry wastes constitutes an interesting alternative to peat as a substrate for the production of vegetable seedlings.

Effect of farmyard manure on carbon incorporation in humus

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Ecological soil functions are closely dependent on soil organic matter. One of the main factors of soil production function is accumulation and conservation of organic carbon and humus. Information about carbon cycling in plant – soil system is very important for the development of sustainable farming systems. Long-term effects of different farming systems are essential agronomic and environmental basis for development of highly productive and sustainable farming systems.

The purpose of present investigation was to study the incorporation of carbon in humus from ^{14}C labeled plant residues as affected by farmyard manure and NPK application in long-term field experiment.

Long-term field experiment on Luvisol sandy loam soil was founded in 1966. During last 15 years crop rotations were as follows: potatoes, barley, pea-oats mixture, winter wheat and flax. Farmyard manure (60 t ha^{-1}) was applied once in 5 years for potatoes. Mineral fertilizer rates in average for crop rotation were N44P44K65.

^{14}C labeled barley residues (0.5 g dry matter) were mixed with soil (300 g) and were placed in special polymer fiber bags with holes. Bags were exposed in arable soil layer. Time of exposition was equal to 30 days. After isolation of humus, fractionation and purification of humic and fulvous acids samples were analyzed for ^{14}C incorporation. C_h, C_{ha} and C_{fa} values, which characterize the percentage of ^{14}C incorporation in humus, humic acids and fulvous acids after decomposition of barley residues in soil, were determined.

After three crop rotations humus content at background of NPK fertilization was reduced by 4.6% and FYM+NPK treatment resulted in the increase of humus content by 4.6% as compared with initial value. The percentage of ^{14}C (C_h) incorporation in humus as a result of long term NPK-fertilizing not exceeds 7.7 - 9.7%. Due to long-term FYM+NPK fertilization ^{14}C (C_h) incorporation in humus achieved 13.7 - 16.4% that was 1.7-1.8 times higher as compared NPK application.

Long-term FYM+NPK fertilizing has led to more intensive ^{14}C incorporation in fractions of humic acids: C_{ha} values were in diapason 5.6 – 8.0 % as compared with (C_{ha}) 2.5 – 4.8% at background of NPK fertilizing. Similar regularity was found for C_{fa} values, which characterized the percentage of ^{14}C incorporation in fractions of fulvous acids: at background of long-term FYM+NPK soil management C_{fa} values were in diapason 8.1 – 8.4% and due to NPK management C_{fa} varied from 4.9 up to 5.0%.

Long-term FYM+NPK management was found to reduce the content of organic matter labile fraction up to 4.9-7.1% as compared with 7.1-11.8% at NPK treatment, that is considered as positive factor indicated on soil organic carbon conservation.

Organic wastes application, as organic fertilizer is the best way of organic wastes utilization. Long-term application of farmyard manure even once in five years (for raw crops) provides significant increase of the participation of plants residue decomposition products in the processes of humus synthesis as well as the reduction of organic matter labile fraction share and is the main precondition for the accumulation and conservation of soil organic carbon.

Long-term excessive organic waste use on environmental impact and sustainability

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The effect of high amounts of sewage sludge and pig slurry (2 and 5 tons of organic matter respectively) applied in a 25 year field experiment were investigated. The change of soil properties, in crop yields and in crop contents during the last years were measured and discussed.

The pH-value of the soil decreased in unfertilised plots or when high quantities of pig slurry was applied. In contrast phosphate content increased considerably with high application of fertilizers. Large amounts of nitrogen in pig slurry together with a decrease of pH-value decreased the yield of the different crops, especially cereals, red roots and celery considerably.

Both, sewage sludge and pig slurry, in general are very valuable organic fertilisers. Nevertheless in consequences of hygienic reasons and risks of organic pollutants and heavy metals the agricultural use of sewage sludge will be forbidden as of 2006 in Switzerland.

Best guarantee for equable crop contents is a well-balanced fertilisation adjusted to the plants nutrient uptake. On unfertilised acid soils the yield of various crops was very low and some crops were also enriched with heavy metals.

Exploitation of composted agricultural wastes as growing media

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Industrial cork residue, grape marc and olive oil husk + cotton gin trash (2/3, v/v) were composted in 40 m^3 windrows and turned each week. Composting took four or five months. During composting grape marc pile and cork pile were fertilized with ammonium nitrate, superphosphate, iron sulphate and magnesium sulphate.

The evolution of temperature, pH, moisture, mineral nitrogen ($N\text{-}NH_4^+$ and $N\text{-}NO_3^-$), total nitrogen, organic matter, C/N ratio, electrical conductivity (EC) and cation exchange capacity (CEC) were measured each week. In order to estimate compost maturity, phytotoxicity test, employing index germination, and nitrogen drawdown index (NDI) were used.

With curing time, organic matter and C/N ratio decreased, whereas CEC increased and pH was constant.

Microbial biomass, microbial activity and nutrient composition were measured in mature compost. Cork Compost showed the highest beta-glucosidase activity followed by grape marc compost. Olive oil husk + cotton gin trash compost showed the lowest activity.

The composts were used as growing media for geranium and petunia during 15 weeks. The worst results were obtained when olive oil husk + cotton gin trash were used in the composted mixtures. In these cases plants showed a lower development and leaf chlorosis. This can be explained as a consequence of nutritional disorders and/or the possible presence of phytotoxic organic substances.

Effects of three consecutive applications of MSW compost on sandy soil under intensive fertilization conditions

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Municipal Solid Waste Compost (sieved < 10 mm; MSWC) from Recycling Plant of Villarrasa (Huelva), was applied to 3 consecutive seasons of horticultural crops (Tomato, zucchini and green pepper) under greenhouse and intensive fertilization conditions. A Control treatment (no organic amendment), and a commercial compost (CC treatment) widely used by farmers in the area (Los Palacios, Sevilla) were applied as comparison. Effects on soil properties at the end of the 3 seasons were studied. Furthermore, residual effects of compost amendments at the end of the 4th season (Tomato), with no treatment applications were also study.

Positive effects were observed in fertilizing parameters after MSW compost applications, compared to both Control and CC treatments. In this way, at the end of the 3rd season, MSWC increased Organic Matter, available-K, available-Ca and available-Mg in the soil, and avoided pH decrease observed in other treatments.

Nevertheless, negative effects due to MSWC applications were also observed. MSWC increased NO_3-N content in the soil at the end of the 3rd season, what could become a problem, specially in sandy soils, because of the danger of groundwater contamination.

After one season without treatment applications, high fertlization used to get high crop yield, masked all these positive and negative effects, and no significant differences were observed between plots of different treatments.

Soil metal contents were also affected by treatments applied. After the 3rd application, MSWC increased total (HCl-HNO_3 digestion) and DTPA-extractable Cu, Zn, Ni and Pb in 0-25 cm layer, and even Zn and Pb in 25-50 cm layer. Soil metal accumulation was a more lasting effect than other parameters studied, and after the season without treatment applications, metal accumulation were still observed.

Effects of sewage sludge application on N dynamics in forest soils: A field study.

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The feasibility of municipal sewage sludge application to soils as a disposal alternative increases with both the amount applied and the number of reapplications. However, the ability of the soil to assimilate N is often a limiting factor. The objective of this research was to study NO_3 and NH_4 leaching after repeated applications of sludge to soils under pine stands. Sludge was applied at four different loading rates (0, 2.4, 17, 60 Mg ha^{-1} y^{-1}, sludge DW equivalent) on days 0 and 371. Soils were sampled once a year to a depth of 53 cm. Leachates were collected at two depths (25 and 50 cm) after heavy rain. The soils under study have low pH (<4.4), low CEC, and low base saturation, typical of soils located in a high leaching environment. Levels of NO_3 and NH_4 in leachates were inversely related. Ammonium levels were highest during the first 400 d of the experiment, and peaked on days 66-266 (maxima of 48.7 NH_4-N mg L^{-1} for the 60 Mg ha^{-1} treatment). This pattern was common at the two depths at which leachates were collected, although the concentrations of NH_4-N at 50 cm depth were generally lower. On the other hand, NO_3-N levels in leachates were initially below 10 mg L^{-1}, but started to increase by day 176, and peaked on days 345-413 (82.5 mg L^{-1} for the 60 Mg ha^{-1} treatment, at 25 cm depth). By this time, levels of NH_4-N were below 7 mg L^{-1}. A second peak of NO_3-N was detected on day 594 at 25 cm depth (88.6 mg L^{-1} for the 60 Mg ha^{-1} treatment) and by days 774-802 at 50 cm depth (96.3 mg L^{-1} for the 60 Mg ha^{-1} treatment), whereas levels of NH_4-N remained low. We are currently investigating whether the history of prior sludge application has had an influence on the patterns observed.

Evolution of the Nitrogen Apparent Recovery Index of Total Nitrogen Solid Manure Applied Every Two Years in a Maize Wheat Rotation

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After spreading, an important fraction of nitrogen solid manure meets the nitrogen stack of soil organic matter. Regular applications of solid manure must, therefore, lead to a progressive increase of nitrogen apparent recovery (NAR) indexes of total nitrogen of these solid manure. Indeed, crops will gain nitrogen not only from the solid manure rate applied at the start of every rotation, but also by an extra mineralisation of the nitrogen stack of the soil organic matter.

Two trials were carried out from 1987 to 1998 on two places of the Brittany Region (West of France) : Kerguehennec and Crécom. Both experimental devices has allowed to appraise the evolution of nitrogen apparent recovery indexes of two solid manure : cattle stored solid manure and stored broiler litter.

Solid manure have been spread every two years before maize sowing in a maize winter wheat rotation. Nitrogen average contents of the applied rates of cattle stored solid manure were 188 kg N/ha at Kerguehennec and 122 kg N/ha at Crécom. Corresponding values for the stored broiler litter were 252 kg N/ha at Kerguehennec et 52 kg N/ha at Crécom.

The NAR indexes of total nitrogen of the solid manure applied every two years on maize has been calculated successively for maize and following winter wheat at Kerguehennec and Crécom. These calculations have not been made when the application of solid manure induced a nitrogen over-fertilisation of the crop. So, the NAR indexes of the stored broiler litter have not been determined for the maize at Kerguehennec.

None significant increase of these indexes were observed during the twelve years duration of both trials as well with maize as with winter wheat. Hence, the mean values of the NAR indexes can be considered as an assessment of the direct nitrogen effect of both types of used solid manure.

The average NAR indexes values found for the maize were 0.11 with the cattle stored solid manure at Kerguehennec, 0.20 with the cattle stored solid manure at Crécom and 0.14 with the stored broiler litter at Crécom. For the winter wheat, the results of Kerguehennec and Crécom were respectively 0.05 and 0.18 with the cattle stored solid manure, and 0.08 and 0.20 with the stored broiler litter.

Comparative studies of the efficiency of lime refuse from sugar beet factories as an agricultural liming material

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Lime refuse from several sugar beet extraction factories has been characterized. Lime scum or lime refuse with a liming capacity (CCE) per t equivalent to 0.85 t of pure lime was used in a field assay to study its behaviour as an amendment material for an acid soil (plinthic Palexerult). A finely pulverized dolomitic lime was used as a reference. The dosage needed to reach a pHw of 6.3 in the first 20 cm of soil was calculated, based on the CCE, humidity and the soil neutralization curve. A total of 6.3 t/ha of dolomitic lime and 7.4 t/ha of sugar factory lime scum were employed. Two years after its incorporation into the soil the effects of the lime scum on the change cations were similar to those caused by the dolomitic lime. Throughout six years and six crops it was observed how, in the plots amended with lime refuse, a slightly higher pH was maintained than that measured in the plots with lime, and with fewer fluctuations. The mean difference in nine samplings between the pH of control plots and that of plots with lime scum was 1.24 units while the mean difference between the pH of the control plots and that of the limed plots was 1.12 units.

Once the maximum pH value was reached in the treated plots, the rate of decline of the pH was similar to the acidification process undergone by the soil in the control plots and fitted the regression:

$$pHw = 0.000435 * daa + 6.93$$

where daa are the days after the application of the amendment.

The recycling of sugar beet factory lime refuse as a liming material for acid soils was seen to be a valuable and efficient alternative to traditional limes and dolomites.

Comparative Study of the Fitness of Various Limestone and Gypsum Byproducts as Improvers of the Agronomic Potential of a Plinthic Palexerult

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The topmost part of a Plinthic Palexerult (Ap and AB horizons) from the Cañamero raña (western Spain) was reconstructed in percolation columns in order to compare the effects of the application of sugar foam waste (SF), phosphogypsum (PG) and red gypsum (RG) on various productivity-related soil properties. Also, the action of the byproducts was compared with that of conventional amendments such as quarry limestone (Ql), and quarry gypsum (QG). the amending byproducts were found to alter the pH and composition of the exchange complex in the Ap horizon; however, only the gypsum-based amendments caused changes in the AB horizon. Sugar foam waste and quarry limestone caused a similar increase in pH, and also similar increase in Ca^{2+} and decrease in Al^{3+} in the exchange complex; however, the SF resulted in smaller losses of exchangeable Mg. Both quarry gypsum and the gypsum-based byproducts caused a slight decrease in aqueous pH (as measured in a 1:2.5 suspension) in both horizons relative to the blank columns —the differences, however, decreased and eventually reverted with time after application of the amendment. The three gipsic amendments caused heavy losses of Mg, as well as less marked decreases in K and Na contents. Finally, they also decreased the Al content in the exchange complex, albeit to a much lesser extent than the calcareous amendments. After treatment with the amount of water equivalent to one year of precipitation in the field, soil from the Ap horizon in each column was subjected to a productivity test in pots that were sown with *Triticum durum* sp and received the same NPK rates used in the field tests but no external calcium or sulphate. Of the three gypsum-based byproducts, RG was that boosting productivity to the greatest extent, followed by PG and quarry gypsum. In any case, SF was the byproduct resulting in the greatest productivity gains. These results can be ascribed to the high content of RG in Zn —a micronutrient in which this type of soil is highly deficient— and to the also high contents of SF in macro and micro nutrients.

Characterization of sludge from fish cage farming in Chile

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Chile is the main salmon producer in the world, generating important income for the national economy. However, fish farm cages located in the sea and lakes produce large quantities of sludge. Utilization of salmon sludge in agricultural soil could be a good management practice to avoid polluting water. This study aims to characterize salmon sludge and, to determine potential use in agricultural soils.

Sludge was collected by divers using a core sampler from the bottom of the cages, in the sea or lake bed. Sampling was carried out in salmon and trout cages farms located in lakes (7) and sea (7) in the South of Chile during 2002-2003. Sludge was analysed DM, pH, OM, macronutrients, micronutrients and heavy metals.

Results showed a high variability among the samples and differences between sea and lake sludge. In general, dry matter contents were low averaging *c.* 12% and *c.* 15% for lake and sea sludge respectively. Sludges showed low organic matter contents with values < *c.* 25% and a neutral pH (c. 7.0 to 8.0). Both sludges had low total N contents (fresh weight basis) with values < 0.2%, where most of the N was in organic form (>75%). On a dry weight basis lake sludge showed high content of P (1.87%), Ca (4.25%), Zn (362 ppm), Fe (26,356 ppm), Mn (442 ppm) and Al (31,147 ppm). Sea sludge has high contents of Mg (1.65%), K (0.63%) and Na (11.8%). Heavy metal contents (As, Cd, Cu, Mg, Ni, Pb, and Zn) were below the limit established by Chilean legislation for sewage sludge.

According to this study is possible to conclude that salmon sludge had low nutrients and heavy metal contents. This sludge could be used in agricultural soils, mainly as a P source, which could reduce the risks of water pollution from the fish farming industry.

The effect of organic residues from different sources on soil properties, fruit production and mineral composition of pepper crop

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Organic amendments to soil can supply nutrients required for maximum crop production and quality, trough proper timing and placement and optimum rates of addition, namely using the most adequate mixtures of organic residues (OR) showing different composition. In this study a pot experiment was carried out to evaluate the effect of different OR on the properties of a Cambic Arenosol, fruit production and mineral composition of pepper fruits. OR tested were: municipal solid waste compost (MSWC), pulp mill sludge (PS), poultry manure (PM) and three mixtures consisting of: 50%MSWC+50%PS, 50%MSWC+50%PM and 50%PS+50%PM (on a dry weight basis). In every treatment an amount of each OR, equivalent to 0.67 g of nitrogen (N) per pot, was thoroughly mixed with the soil. A control treatment with the same amount of N as ammonium sulphate was performed. A basal fertilization of 0.44 g phosphorus (P), 0.83 g potassium (K), and 0.30 g magnesium (Mg) was added per pot. Thirty days after plantation soil samples were taken and all pots started to receive a top dressing fertilization consisting of 0.075 g of N and 0.05 g of K. During the experiment ripe fruits were counted, harvested, weighted and dried for further analysis. At the end of the experiment soil samples were collected to be analyzed. Results showed that OR led to significant increases of soil pH values being particularly evident on MSWC treatments. The use of MSWC also led to a significant increase of soil sodium content (Table 1).

Table 1. Physical and chemical characteristics of the soil at the end of the experiment

Treatments	pH	O.M. g kg^{-1}	Na dil.1:5 mg kg^{-1}	Cu mg kg^{-1}	Fe mg kg^{-1}	Zn mg kg^{-1}	Mn mg kg^{-1}
Control	5.03d*	5.80 a	19.5 b	18.37 b	43.73 b	4.20 ab	7.60 b
MSWC	6.23 a	6.80 a	60.33 a	23.93 a	60.40 a	5.30 a	8.90 ab
PS	5.73 bc	6.40 a	22.83 b	21.27 ab	46.13 ab	4.67 ab	10.10 a
PM	5.60 c	6.50 a	24.00 b	19.33 b	42.80 b	3.93 b	9.03 ab
50%MSWC+50%PS	5.97 ab	6.60 a	25.67 b	20.60 ab	49.93 ab	4.67 ab	9.50 ab
50%MSWC+50%PM	5.87 bc	7.10 a	28.33 b	19.70 b	48.40 ab	4.60 ab	9.13 ab
50%PS+50%PM	5.70 bc	7.20 a	19.50 b	20.87 ab	48.30 ab	4.53 ab	10.30 a

* Means in the same column followed by different letters are significantly different at $p< 0.05$

Although the application of OR caused an increase of soil extractable copper (Cu), iron (Fe), zinc (Zn) and manganese (Mn), the content of these micronutrients on fruits composition was lower than those from control treatment. On treatments where OR were applied a greater fruit production was observed. However, no significant differences were detected between treatments. The lowest production was obtained for control due to a decrease of soil pH values caused by mineral basal N fertilization, since this soil shows a very low buffer capacity.

Relative Contribution of Crop Residue Bound-N to Irrigated Rice and Carbon Storage in a Subtropical Soil

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Maintenance of soil organic matter is an essential component of soil fertility management and sustainable crop production. Addition of organic residues can play a dynamic role to that effect instead of burning or taking out of the crop fields for fuel/animal feed, causing a large release of air pollutants. An investigation onto the effect of preceding rainfed rice crop residue and root biomass on soil organic carbon (SOC) storage and nutrient uptake by a succeeding irrigated rice was carried out in a non-calcareous sandy loam soil of subtropics. Decomposition of incorporated crop biomass was rapid until 40 days after transplanting and the residue-amended plots depicted higher peaks for CO_2 evolution. An increasing trend of it was observed at the end of the crop cycle, attributed to the drying process. Ammonification was faster during the initial period followed by its oxidation, indicating dominant microbial activities in the surface layer (0-2.5 cm). Thereby fluctuations of mineral N, where NO_3^- levels were smaller, revealed the influence of fertigation, N uptake and loss processes. Figure 1 shows that T4 treatment depicted a significantly higher grain yield of rice (8 t ha^{-1}) and apparent added N recovery (62.7%) than with an additional amount of crop residue (T5). This is ascribed to the poor recovery of added biomass-N for the latter (1.3%) due to probable N immobilization. The T1 and T2 treatments did not show significant influences on the yield and N recovery. The relative contribution of root biomass to grain yield and N recovery was smaller (9 and 7.6%). At harvest, SOC increased up to 3.8-28.3% with the amount of incorporated crop biomass over initial levels. The crop residue-amended plots contributed more to some N build-up likely through N mineralization at the latter period of crop cycle. Results suggest that application of crop residue to an appropriate amount along with inorganic fertilizers did not limit crop yield rather improved soil fertility status.

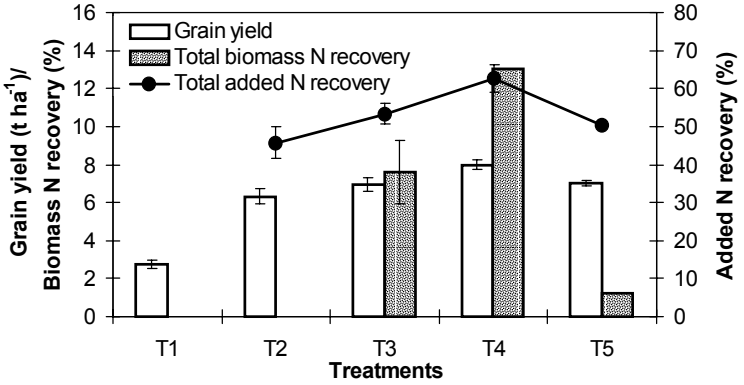

Figure 1. Grain yield, total biomass- and added-N recovery of irrigated rice as influenced by inorganic and organic inputs (T1 = control; T2 = inorganic fertilizers only; T3 = T2 + root biomass; T4 = T3 + crop residue (20 cm height) and T5 = T3 + crop residue (40 cm height). Vertical bars indicate standard error.

A comparative evaluation of biowaste utilisation versus other fertilizers using the notion of CO_2 equivalence

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The departure point of the study was to develop a definition for the fertilizer equivalent (FEQ). This FEQ corresponds to the sufficient amount of nutrients (N, P_2O_5, K_2O) required to fertilize one hectare of land used for agricultural purposes. Meeting the FEQ requirements could be achieved by the use of mineral fertilizers, or the use of compost.

Trials done using mineral fertilizer were used as a control scenario. In this case the FEQ requirements were met using mineral fertilizers only. Biowastes were not separately collected for composting and were instead submitted to thermal mechanical-biological waste treatment along with the rest of the residual waste, which is the municipal solid waste remaining after particular waste components destined for special collection have been sorted out and removed. A further disposal option was the landfilling of waste. The results of the trials done using compost comprised the comparison scenario. In this case the FEQ requirements were met using compost only. In the comparison scenario, biowastes were separated out and submitted to aerobic or anaerobic/aerobic treatment processes. The resulting materials were used to produce compost. Residual municipal solid wastes were treated similarly as in the control scenario.

The environmental debts and credits, in terms of the release of climate-changing emissions, were evaluated for each scenario and the results were compared. All the investigated scenarios that involved the use of biowaste as a fertilizer were environmentally favourable with respect to lessening the greenhouse effect. Compared to the scenarios in which no biowaste composting was involved the savings, in kg of CO_2 equivalents per hectare and year, ranged between 13.5% and 22%. Within the comparison scenarios themselves, the trials using anaerobic/aerobic processes were more advantageous. The reason for this result is that anaerobic/aerobic methods have a positive energy balance compared to aerobic methods alone. The production and thermal utilisation of biogas can result in a surplus of electrical energy. For the anaerobic/aerobic biowaste treatment, the savings in CO_2 equivalents were between 12,200 kg and 14,300 kg per hectare and year, depending on the process used. For the aerobic biowaste treatment, the savings in CO_2 equivalents were between 6700 kg and 8500 kg ha^{-1} $year^{-1}$, again depending on the process used. In terms of lessening the greenhouse effect, the utilisation of biowastes is a good option for recycling these wastes. The advantage lies in the production of compost, which can be used for agriculture. This advantage is not primarily in the form of finding a substitute for mineral fertilizers, whose greenhouse emissions are negligible in comparison to the other methods studied, but it is in using composting or fermentation process for the treatment of biowaste.

Effect of a composted sewage sludge on the performance of mycorrhizal *Retama sphaerocarpa* L. seedlings afforested in a degraded soil under two water regimes

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The establishment of autochthonous plant species is a widely used practice for reclaiming degraded lands in Mediterranean semiarid areas. To carry out successful reafforestation programmes, it is necessary to apply methods which improve soil quality, such as addition of organic amendments and the ability of the planted species to resist semiarid environmental conditions by mycorrhizal inoculation (Caravaca et al., 2003) .

We studied the effect of inoculation with three arbuscular mycorrhizal (AM) fungi (*Glomus intraradices*, *Glomus deserticola* and *Glomus mosseae* and the addition of composted sewage sludge (SS) on root nitrate reductase activity, mycorrhizal colonisation, plant growth and nutrient uptake in *Retama sphaerocarpa* L. seedlings afforested in a semiarid degraded soil, under well-watered and non-watered conditions.

A factorial design in randomised blocks was established with three factors and five-fold replication. The first factor had two levels: addition or not of composted sewage sludge to the soil, the second had four levels: non-inoculation, inoculation of *R. sphaerocarpa* plants with three AM fungi, and the third had two levels: well-watered or non-watered conditions.

Six months after planting, the mycorrhizal inoculation and the irrigation of plants had a strong effect on the growth parameters. There was a negative interaction between plant irrigation and mycorrhizal inoculation and a positive interaction between plant irrigation and composted SS addition, with respect to increasing plant growth. The composted SS addition had a significant, but moderate, effect on the growth parameters but conferred no additional benefit when combined with mycorrhizal inoculation. Mycorrhizal inoculation, composted SS addition and plant irrigation had a significant effect on NR activity in roots and on foliar nutrients. The irrigation of plants significantly increased the positive effect of the addition of composted SS on NR activity and the contents of foliar N and K.

The effect of mycorrhizal inoculation on NR activity did not depend on the water regime. The effectiveness of mycorrhizal inoculation on the establishment and growth of *R. sphaerocarpa* seedlings in a semiarid Mediterranean area was independent of water regime. The addition of composted SS was only effective when water availability in soil was high. The combination of mycorrhizal inoculation and composted SS addition had no synergistic effect on plant growth.

Meat and bone meal: fertilizing value and rates of nitrogen mineralization

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The Bovine Spongyform Encephalopathy (BSE) crisis have caused that large amounts of meat and bone products, formerly used for animal feeding, are currently being disposed of in landfills and incineration plants. These materials are very rich in aminoacids, nitrogen and phosphorus and, when sanitary safety is guaranteed, can be used in agriculture as fertilizers. In fact, they have been commonly accepted as such in the normatives regulating Organic Farming in some European countries. The analytical characterization of several meat and bone meals elaborated in the Valencian Region (Spain) have shown very remarkable contents of many nutrients, and the agronomical evaluation of two products by means of a greenhouse experiment yielded very promising results. A set of incubation experiments are currently on course to provide rates of nitrogen mineralization of five different products and three soils. The final results are expected to be available before the deadline of the full paper submission.

Peculiarities of the action of microbial fertilizers from livestock waste in “soil-plant-microorganisms” system

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Modern biotechnology allows using microorganisms to process livestock farm waste into effective microbial fertilizers. These types of fertilizers appeared at the end of the XX-th century and since than have been used in sustainable agriculture. They combine positive features of both mineral and organic fertilizers and do not have their shortcomings. However, the mechanism of microbial fertilizer action in the system “soil-plant-microorganisms” is not studied yet.

Our research showed that microbial fertilizers applied into soil in comparatively small rates (1-2 t/ha) effect the “soil-plant” complex not only due to the introduced plant nutrient elements (as mineral fertilizers), but also due to the activation of soil microflora with acceptable organic matter. As the result, the following soil parameters increased: intensity of mineralization processes; humus synthesis; carbon and nitrogen immobilization in microbial biomass. All these led to soil fertility increase and ensured the effect of microbial fertilizers on soil for further several years.

The results obtained served as a scientific ground for the application of microbial fertilizers not only in sustainable agriculture, but also in the reclamation of contaminated soils.

Characterization of the wastewater from the two-phase centrifugation system for olive oil extraction

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From the earliest nineties most of the olive oil industries of Andalusia adopted the so-called two-phase centrifugation system. This system reduces to a minimum the use of hot water during the centrifugation in comparison with the classical three-phase system (1.3-1.4 L kg^{-1} of olive), and produces oil and a solid residue constituted by pulp, stones and vegetation water (alperujo) containing 55-75% of moisture and 3.4% of oil. The higher moisture content of alperujo in comparison with that of the solid residue generated by the three-phase system (orujo), and the content of soluble organic compounds (carbohydrates, pectines and polyphenols) coming from vegetation water, constitutes the main problem for the chemical extraction of the residual oil.

Despite of the saving of water during centrifugation, the two-phase system generates a new liquid effluent – mainly constituted by water used in other stages of the process. This effluent is produced at a rate of ca. 0.25 L kg^{-1}, theoretically supposing a reduction of the volume of the liquid effluent compared with that produced in the three-phase system, the so-called "alpechín". At the same time of the organic pollution load of the two-phase effluent is much lower than the corresponding of alpechín.

The present communication deals with the result of a survey carried out in six industries located in Cordoba province to determine the volume and chemical characteristics of the effluent generated by the two-phase system.

The volume of effluent generated ranges between 0.2 and 0.5 L kg^{-1} of olive (average 0.3 kg^{-1}) what represents a reduction of 1 L kg^{-1} in comparison with the alpechín produced by the three-phase system.

Table 1. Chemical characterization of the wastewater from the two-phase extraction process

		pH	EC dS m^{-1}	COD	TSS	Fat g L^{-1}	K	Na
Alperujo	Average	5.20	3.30	23.7	5.01	1.10	1.1	0.05
	Range	3.89-6.73	0.52-7.56	1.1-90.3	0.2-31.2	0.13-7.0	0.45-3.5	0.45-3.5
Alpechín	Range	4.7-5.2	7-16	45-60	9.0	3-10	2.7	0.3

EC, electrical conductivity; COD, chemical oxygen demand; TSS, total suspended solids.

An important reduction of the values of chemical oxygen demand (COD), electrical conductivity (EC), suspended solid (FSS) and the fat content was observed in comparison with the data recorded for the "alpechín" (Table 1). Nevertheless these values are still higher than those allowed by the Spanish lows and therefore the discharge of this effluent into the watercourses has to be limited and controlled. Alternative uses of these waters are proposed.

Microbial biomass and activity of an agricultural soil amended with the solid phase of pig slurry

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The improvement of the organic matter content in Mediterranean soils is a main concern in soil management, especially in highly intensive agricultural areas. The solid phase of the pig slurry could be a good soil amendment, not only for its high nutrient content but also as an organic matter supply for the microbial populations enhancement. The objective of this work was to study the effects of the application of the solid phase of pig slurry (composted or non-composted) in an agricultural soil on the microbial biomass and activity. Thus, basal respiration, microbial biomass carbon, qCO_2, total organic carbon, carbon mineralisation kinetics and mineralised nitrogen were monitored in amended and non-amended soil samples.

The soil used was a Typic Xerofluvent with a high intensive agricultural use. Samples of this soil were mixed with two manures derived from the solid phase of pig slurry (composted, CSP, and non-composted, NSP). The manures were applied in soils at two rates, adding 7 and 14 g organic C kg^{-1} soil, respectively, in 300g soil-pots, being five treatments established: 1) Control: soil without manure; 2) NSP1: soil + NSP at rate 1; 3) NSP2: soil + NSP at rate 2; 4) CSP1: soil + CSP at rate 1; 5) CSP2: soil + CSP at rate 2. Then, soil samples were incubated (aerobically, non-leached conditions) during 163 days at 25ºC and a moisture content of 60% WHC. Four pots per treatment were collected and analysed at 3, 20, 41, 62, 90 and 163 days of incubation period.

Amended samples showed higher rates of respiration compared to the control samples, according with the manure rate application. Slight differences of respiration rates were observed between manures, being higher for the NSP-amended samples. The highest respiration rate of non-amended (control) samples was at first sampling (3 days of incubation period), whereas in amended samples it was at 20 days. This fact could be because of a lag-phase of microbial populations. In this sense, the maximum microbial biomass increments were not immediately recorded after amendments. Organic C mineralization could be fitted to simple models.

The metabolic quotient (qCO_2) increased with the organic amendments, due to the presence of easy decomposable compounds, and microbial population changes. Along the incubation period, this parameter in amended soils clearly trended to decrease.

In relation to nitrogen mineralisation, ammonium rapidly decreased, being nitrified, volatilised and immobilised by microorganisms. Whereas in the nitrate content, different patterns were observed between samples amended with CSP and NSP manure type, being lower in the CSP-manure amended soils, probably due to the presence of more recalcitrant organic nitrogen of this waste after composting, enhancing inorganic nitrogen immobilisation by microbes. The use of the solid phase of pig slurries, composted or not, could be a feasible practice to enhance, in a short-term, the microbial biomass and activity of agricultural soils.

Agronomic use of the solid phase of pig slurry on cucumber crop: nutrient extraction and biomass production

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The use of swine manure slurry as organic fertiliser represents an economical and widespread method, which can improve the soil properties and recycle nutrients in agricultural soils, thus reducing the need for mineral fertilisers. In this experiment the effect of the fresh and composted solid fraction of swine manure slurry on major nutrient NPK status in different plant parts (stem, leaves and fruits) using different application rates of each waste was studied, compared to traditional inorganic fertilisation. The biomass production (commercial and total aerial mass) was also monitored. Fertiliser treatments were: MF, mineral fertiliser (with a complex 16 N-16 P_2O_5-16 K_2O) equivalent to 300 kg N ha^{-1}; FSF and CSF, organic fertilisation with fresh and composted solid fraction of swine manure slurry, respectively, at two different rates (supplying 300 kg N ha^{-1} and 450 kg N ha^{-1}) and C, a control treatment without fertilisation.

In general, N concentration in the different plant parts analysed was not increased by the biosolids amendment and the application rates, compared to the inorganic fertilisation (MF). Similar or lower N extraction was observed with the increasing application rates of the solid phase of pig slurry, this aspect being more significant for the composted biosolids (Table 1). P extraction and plant content were positively affected by the organic amendment, with similar increase of this element for the composted and non-composted material. K concentration in the analysed vegetal plant was not increased significantly by the fertilising treatments compared to control plants. This effect could be due to the dilution effect due to a higher biomass production in fertilized scenarios.

The use of the fresh and composted solid fraction of swine manure slurry as organic fertilisers produced a similar or higher yield of fruit and biomass of cucumber plants than the mineral fertiliser. In general, increasing rates of organic fertiliser application did not result in greater biomass production. This fact is especially important for establishing the application rates for the composted solid fraction, where a reduction of the biomass production with the increment of rate was detected.

Table 1. NPK plant extraction.

Treatment	N (mg/plant)	P (mg/plant)	K (mg/plant)
C	2698 a	656 a	5190 a
MF	3551 c	886 b	6481 bc
FSF-300	3122 b	948 bc	6933 c
FSF-450	2920 ab	1086 de	6537 bc
CFS-300	3747 c	1136 e	8333 d
CFS-450	2822 ab	1035 cd	6184 b
ANOVA	***	***	***

Fertilising value of phosphorus from urban and agricultural organic waste

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Organic wastes contain quantities of phosphorus potentially available for the plants, which justify their use in agriculture. However it is difficult to recommend the use of organic waste under phosphate fertiliser insofar as the availability of phosphorus is badly known. Consequently, in practice, organic waste spreading does not take sufficiently into account the corresponding phosphorus supply.

The aim of this contribution is to present a synthesis of several studies of the relative phosphorus availability (RPA) of sewage sludges, municipal composts, solid and liquid manures, following the same method. The RPA expresses the availability of the phosphorus of the waste compared to that of a soluble mineral phosphate.

This method consists to cultivate ray-grass (*Lolium perenne* L.) in greenhouse experiments during three to four months. Before mixing the organic waste or the soluble mineral phosphate with the soil (P deficient silty soil), P ions of the soil are labelled with radioactive ^{32}P. The determination of the total P and isotopic composition of P taken up by crop allows to differentiate phosphorus coming from the soil from phosphorus coming from the tested waste or soluble mineral phosphate.

Among several indicators of P availability, the contribution of the P supplied by waste to the total P taken up (=Pdff) appears to be the most reliable. Approximately 60 situations (soil x wastes) were tested. The values of RPA are presented in table 1

Table 1 Relative phosphorus availability of urban and agricultural wastes

Products	Treatment	RPA %
Soluble mineral phosphate		100
Sewage sludge	biological, and treated with :iron salts or iron salts and lime	
	lime	92(18, ±16)
	physico-chemical with iron salts or iron salts and lime	88 (6, ±5)
	digestion and treated with iron salts or iron salts and lime	
	thermic treatment	71(16,± 20)
	composting	73 (5, ± 18)
Municipal compost	composting	84 (1)
Biowaste	composting	54 (1)
Bovine manure		76 (4, ±8)
Pig manure		99 (5, ± 8)
Poultry faeces		87 (2, ±15)

Waste is effective sources of P. If one takes into account the values of RPA a better reasoned management of the P fertilisation is possible

Waste organic matter quality versus soil amendment effects

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The organic matter OM content of organic wastes is not a sufficient parameter to predict the evolution of OM into soils; the OM quality is of capital importance to evaluate their possible amending capacity. The working documents prepared by European Commission on land reuse for biowastes and sewage sludges establish different quality products according their chemical content (heavy metals and organic compounds) and hygienisation conditions (removal of pathogen organisms), but does not consider any specific parameter related to OM quality other than the Respiration Activity or Dynamic Respiration Index, which express their biodegradability capacity. The aim of this paper is to discuss the meaning of several parameters obtained by simple and rapid laboratory methods in order to qualify the OM stability to predict the long term OM evolution in soils when biowastes are applied.

The studied samples belong to several Spanish composting plants, which treated residues from different origin and using various composting system. In all cases the samples represents the end product suggested by the plant technical personal. To characterise the OM stability both total organic matter (TOM) and resistant organic matter (ROM) contents has been used. The TOM was determined by ignition at 560º C and the ROM by two successive hydrolysis with H_2SO_4. In some samples the biodegradability was also evaluated by self-heating test (Rottegrade test).

The OM quality of more than 100 compost samples has been determined. Comparing the results a good relationship between ROM/TOM, stability degree and conditions of composting process is observed.

The Use of Composted Waste as a Growing Medium or Peat Diluent

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Due to environmental concerns regarding the preservation of peatlands in their original state, customers and various EU governments are demanding a reduction in the use of peat. For instance in the UK where this policy is strongest, they want to reduce the peat usage in growing media and soil improvers to about 10% by 2010. In addition due to increased impetus on recycling as a result of government policy to reduce organic waste going into landfill there is a general perception that some of these wastes could be used as components of growing media. We will present results on the use of various processed organic wastes such as composted green waste, forestry waste and brewery waste as a growing medium or as a peat diluent. This will include physical, chemical and microbiological effects on peat as result of the addition of these materials. For instance we will show the physical effects of addition on aeration, water holding capacity and bulk density and chemical effects on availability or immobilisation of certain nutrients. Fertilisation of peat has to take this into account**.** The effect of adding composted material on bacterial and fungal populations and on the biodegradability of peat will be shown. Finally, results will be presented to show the effect of these additions on plant growth and the limits on the percentage that these wastes could be used as peat diluents.

High nitrogen, disease- and nematode-suppressant compost as a medium for organic container-grown crops

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Except for labour, nitrogen is the main input in organic vegetable production. Most commercial composts contain only small amount of available N. Our objective was to minimize N losses during composting of separated cow manure (SCM), while ensuring maximal compost's suppressiveness against soil-borne pathogens.

Nitrogen loss during composting of SCM was minimized using high C/N (wheat straw, WS; grape marc, GM) or a slightly acidic (orange peels, OP) additives. N conservation values in the resultant composts were 82%, 95% and 98%, resulting with N contents of 2.63, 2.84 and 2.39% for GM-SCM, OP-SCM and WS-SCM, respectively. The nutritional contribution of the composts was assessed by means of incubation experiment. The composts later served as media for organic container-grown plants using cherry tomato (*Lycopersicon esculentum* Mill. CV. Hazera 139). Peat moss served as a control. All media were either unfertilized or fertilized with guano (sea-bird manure). Plant responses suggest that N availability is the main variable affecting growth. Unfertilized OP-SCM and WS-SCM supplied the N needed for at least four months of plant growth.

Root-galling index (GI) of tomato roots and number of eggs of the nematode *Meloidogyne javanica* were reduced by the composts, with the highest reduction obtained by OP-SCM and WS-SCM. These composts, but not peat, prevented the spontaneous incidence of crown and root-rot disease in tomato and caused a dramatic decline in the population size of the causal pathogen, *Fusarium oxysporum* f. sp. *radicis-lycopersici*, after artificial inoculation.

The above experiments were replicated 3 times with essentially identical results. It is concluded that nitrogen losses can be minimized using simple means and that high-N composts can satisfy up to 50% of the plant N needs. The composts can substitute for fungicides and nematicides. To achieve this goal, compost should constitute at least 50% of the medium.

Application of pig slurries in the Guadalentin valley for broccoli and watermelon production: influence on some soil chemical characteristics.

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This paper is aimed to determine the effects of application of pig slurries (PS) to the soil as an organic fertiliser in SE Spain. The main interest is to find out the optimum dose that can be added to the soil as an organic fertiliser. The study will enable to determine the potential agronomic use of these pig residues, which are a high-priority issue for the Guadalentin Valley. This paper reports the results obtained after two consecutive years application to fertilise broccoli and watermelon plantations. A 2.100 m^2 plot has been prepared for both: broccoli and watermelon. Different dose, residual and accumulative effects are considered.

As regards to the characteristics of the pig slurries, they are similar to others, although both total nitrogen and heavy metals are lower, as those parameters are strongly influenced by the feeding of the animals and the cycle of production.

The influence of the PS on soil chemical characteristics of and on production is less notorious in watermelon experiences. Metals Cu, Zn, Mn and Fe in general increase for both plantations, however, these contents are not above those established by law. In both crops, the content of nitrate is not influenced by PS after two years of experiment. These contents are before those established by law.