VALUE OF PIG SLURRY FOR AGRONOMICAL USE: AN OPTION IN ORGANIC FERTILISATION

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1 INTRODUCTION

A significant growth in pig farming in Murcia has occurred in the last 25 years. This fact has resulted in an important increase in the number of animals and intensive pig farms and their concentration in certain production areas, so that, the slurry management has become an important issue for farmers. Surplus manure from intensive livestock production is a recognised environmental hazard as its mismanagement threatens the quality of water resources and contributes to emissions of ammonia (NH), methane (CH_4) and nitrous oxide (N2O). For these reasons, farmers search for options to reduce environmental impacts of excess manure, while remaining productive and economically viable. To safely handle the slurry produced on a intensive pig farm in compliance with the environmental legislation, may require substantial capital investment in storage capacity. Slurry spreading may also tie up either considerable farm labour resource or incur further annual expenditure on specialist contractor fees. Given the costs and investments required, it is important to ensure that the management practices employed make the most efficient use of the nutrients available from slurry, to minimise fertiliser costs. Nevertheless farmers are only allowed to apply the slurry to land in a controlled amount according to the current regulations (RD 261/1996). These regulations on the use of animal manure were made in order to reduce risks of eutrophication of the aquatic environment. To maximise the utilisation of manure N it is important to know how much is available to crops and also to take into account the residual manure N in the years following application.

Thus the agronomic use of these organic manures could be a very good solution in order to contribute to the restoration and reclamation of agricultural and marginal lands, improve the amount and quality of stable organic matter and fight against progressive desertification processes. For these reason, a Cooperative Project has been set up to assist farmers in the sustainable use of pig manures as an organic fertiliser. The present work aims to provide an evaluation of the value of the raw pig slurry, within present economical and ecological constraints and studies the effects of its application on soil.

2 MATERIALS AND METHODS

The following work was carried out in the area representing the first one Murcia, SE Spain, with the highest pig production, as well as is the most important horticultural area. For this work, a total of 5 Farmers (F) and 5 Pig farmers (PF) were selected, according to the optimal distance between them.

It is well established that animal manures are a valuable source of plant nutrients and that fertiliser costs can be reduced by recycling the nutrients in manure. It is therefore important to have accurate information on the composition of these animal wastes so that they can be successfully integrated into a fertiliser programme (Tunney and Molloy, 1975).

In this way, slurry and soil samples have been analysed for physical and chemical characteristics before and after use as a soil amendment, for three consecutive years of the development of this study. Then, pH, electrical conductivity (CE), N, P and organic C content are studied in order to calculate the application dose of those previously valorised slurries in agricultural soils.

The soils and pig slurries samples presented in this work, were collected in two consecutive years, 2008 and 2009. Soil samples were collected at surface level and at a depth of 30cm, with and without slurry application, in order to see the influence of this application on soil composition.

With regard to pig slurries, three randomized samples were collected (named as PF) from each Pig farmer selected. All the samples were analyzed by standards methods for determining soil suitability for manure application.

Values of total N (Duchafour, 1970), pH (Peech, 1965), electrical conductivity (Bower and Wilcox, 1965) and total P (Watanabe and Olsen 1965) were evaluated in soils. In the same way, pH, EC, total N, NH_4+ and P analysis data were obtained for the pig slurry samples.

The amount of pig manure to apply was calculated according to the N content obtained from analysis, as well as the current regulatory limit with regard to N addition to agricultural soils (RD 261/1996).

In spite of evidence indicating that ammonia volatilisation can be reduced and the utilisation of slurry N improved by direct injection of slurry (Sorensen, 2002), during recent years, surface-banding of pig slurry in an established crop in spring has become a very popular application method, because this technique is more easily compatible with slurry application by tanker. For this reason, in this study, the slurry pig was applied by surface spreading using a tanker.

Analysis of variance was carried out by using SPSS procedures. Statistical differences were considered significant when $P \leq 0,05$.

3 RESULTS AND DISCUSSION

The pig manure is applied as slurry. In this region, farmers apply the slurry to land from late winter to early summer (with a few exceptions) due to characteristics of crops and the climatic conditions, as well as to minimise the risk of odour emissions.

When slurry data are studied (TABLE 1 and 2) they show that the composition of analysed samples is different for 2009 as compared to 2008, as a result of the changes that occur from one year to another in terms of handling, animal feeding and cleaning of facilities. These changes are related to a number of factors, including economics, weather conditions, sanitary conditions, etc. However, the level of nutrients observed in soils seems not to be strongly influenced by slurry composition.

TABLE 1 **Pig slurry analysis results, 2008.**

PIG FARMER	EC dSm-1	pH	Moisture (%)	NH4+ (g/L)	TOTAL N (g/L)	P (mg/L)
PF1	30,27±0,21	6,36±0,03	96,02±0,17	2,12±0,009	2,46±0,54	94,00±28,79
PF2	40,77±1,70	7,38±0,17	89,15±11,11	4,35±0,23	6,26±0,12	111,67±46,74
PF3	25,73±0,32	8,19±0,15	96,52±0,97	3,00±0,04	3,95±0,14	174,33±26,08
PF4	31,77±0,42	7,91±0,06	97,26±0,32	3,31±0,42	5,05±0,17	207,00±33,05
PF5	30,27±0,95	7,63±0,33	98,34±0,09	3,34±0,09	3,87±0,19	270,00±71,00

TABLE 2 **Pig slurry analysis results, 2009.**

PIG FARMER	EC dSm-1	pH	Moisture (%)	NH4+ (g/L)	TOTAL N (g/L)	P (mg/L)
PF1	27,75±0,92	7,12±0,06	84,4±11,44	2,15±0,63	2,51±0,68	75,5±20,10
PF2	36,50±0,1	6,95±0,05	92,22±1,07	3,15±0,44	2,50±0,25	323,3±10,29
PF3	26,53±1,64	7,44±0,02	89,02±1,23	2,79±0,07	3,12±0,05	397±15,03
PF4	28,97±0,29	7,73±0,02	91,26±0,53	2,48±0,021	2,93±0,02	110,7±21,33
PF5	41,67±1,97	7,71±0,02	95,23±1,08	5,58±0,35	6,64±0,31	277,7±12,05

When soil analyses are considered (TABLE 3), it is possible to see that pH values ranged from 7,6-8,3 corresponding with a basic soil (Porta *et al,* 1999). The electrical conductivity ranged between 1.5 and 0.2 dS m^{-1} at 25ºC, that allows to classify the soil as a non saline soil (EC=0-2 dS/m) or slightly saline soil (EC=2-4dS/m).

However, it is necessary to take in account that changes in the chemical composition of the soil caused by application of manure are much influenced by factors such as soil texture, rate, time and method of application of manure, the amount of local precipitation, and the crops grown, as well as the animal and farm management. In this work, the climatic variation has a minimum influence because of the study has been developed in the same region with similar meteorological conditions.

Farmers often have a choice between different slurry application methods. During recent years surface-banding of pig slurry in an established crop in spring has become a very popular application method. However, experiments indicate that ammonia volatilisation can be reduced and the utilisation of slurry N further improved by using direct injection of slurry (Sørensen and Amato, 2002). The direct injection method is expensive and requires more complex and expensive equipment. So the application method used for this study was the surface banding.

With respect to total N content, the highest concentration of N is located in the surface for both studied years, in all cases. Data showed no significant differences for N leaching from surface to depth of 30cm samples in the five soils evaluated after two years of apply (significance level of $P \leq 0.05$). Manure application also results in accumulation of NO_3-N, and extractable P in the subsoil (Pries, 1996). The level of accumulation increased with the rate of application, but in this study the dose applied is low in relation to regulatory limits (RD 261/1996). These results show that surface banding of pig slurry under the regional climatic conditions may result in a very poor first-year utilisation of slurry N because of immobilisation in combination with volatilisation losses.

The organic C data (OC) showed that the percentage in 2009 (ranged from 0.42±0.10 to 1.54±1.08%) is higher than 2008 (ranged from 0.41±0.17 to 0.98±0.57%) (TABLE 3). The amendment caused an increase in organic C, respiration rates, the microbial biomass C, mineralization coefficients and the numbers of fungi and bacteria. After two years these effects are still present (Guerrero et al., 1998). These increments are related to the application rate. In our case the application rate is the minimum established by the current regulations, and a smaller effect was observed on the OC, so that the levels of OC have no statistical differences before and after slurry application.

TABLE 3 **Results obtained in soils the two last years of study.**

FARMER	CODE	SAMPLE	pH	EC(µS/cm)	TOTAL N 2008 (g/kg))	TOTAL N 2009 (g/kg)	P 2008 (mg/kg)	P 2009 (mg/kg)	OC 2008 (%)	OC 2009 (%)
1	F1	SL	7,83	941,83	1,26±0,23	1,52±0,41	236,15±76,52	650,10±363,16	0,82±0,18	1,54±1,08
		D30 cm	8,19	462,33	0,92±0,07	1,25±0,25	140,18±48,52	463,62±96,13	0,55±0,09	1,28±0,45
2	F2	SL	7,81	1203,00	2,17±0,66	1,13±0,17	313,33±138,70	259,37±44,81	0,98±0,37	1,33±0,20
		D30 cm	7,86	1544,82	1,81±0,27	1,02±0,20	159,95±82,45	262,28±48,80	0,64±0,23	1,15±0,17
3	F3	SL	8,35	240,87	0,87±0,36	0,55±0,12	257,84±76,32	316,28±72,38	0,68±0,27	0,62±0,14
		D30 cm	8,09	682,43	0,62±0,18	0,51±0,13	177,45±66,01	237,03±58,92	0,41±0,17	0,84±0,28
4	F4	SL	7,64	885,00	1,12±0,09	1,02±0,11	545,45±150,34	474,75±77,56	0,89±0,22	0,66±0,29
		D30 cm	7,80	1141,71	0,89±0,17	0,95±0,14	360,2±95,25	349,60±72,63	0,73±0,20	0,58±0,21
5	F5	SL	8,05	442,00	1,42±1,26	1,14±0,14	427,16±204,15	380,69±221,06	0,80±0,28	0,50±0,13
		D30 cm	8,07	913,75	0,759±0,14	0,88±0,16	353,48±120,19	283,07±112,98	0,68±0,24	0,42±0,10

SL= SURFACE LEVEL
D30Ccm=at a depth of 30 cm

4 CONCLUSIONS

The results obtained showed that pH, CE and N content in soils have not increased significantly after slurry application, which means that salinity characteristics of soils have not changed following slurry application, whereas P content and organic C have increased after two years of application. Therefore, further studies are necessary in order to evaluate the cumulative effects of consecutive pig slurry applications over a period of several years.

Organic matter amendments to soils are of particular interest, not only because of their effects on soil physical, chemical and biological fertility, but also because their potential buffering effect which may reduce soil pollution caused by excessive or unbalanced use of mineral fertilizers (Vasconcelos and Cabral, 1996).

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