ECONOMIC ADVANTAGES OF PIG SLURRY USED AS ORGANIC AMENDMENT

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1 INTRODUCTION

The pig farming industry has grown in Murcia in recent years. This fact involves an important slurry accumulation close to the farm. Slurry management plays a crucial role in the integration of crop and livestock production systems and the interaction between agriculture and the environment. Excess manure from intensive livestock production is a recognised environmental hazard as its mismanagement threatens the quality of water resources and contributes to emissions of NH3, CH4 and N2O. For these reasons, farmers search for options to reduce environmental impacts of excess manure, while remaining productive and economically viable. One interesting option is the agronomical use for slurry as an organic fertilizer that besides being an additional source of nutrients to plants is also an alternative for manure disposal (Ceretta et al., 2005)

Given the volume of slurry generated in Murcia, and the total cultivable area and considering the legislation, RD 261/1996, which allows a maximum application of 170 kg N/ha/year in areas designated as vulnerable, it is estimated that to implement the slurry generated in the region in a year, would require only half the arable land devoted to irrigation. However, nitrogen and phosphorus losses by surface run off in no tillage can decrease the efficiency of organic fertilizers and also be a potential pollutant, threatening the quality of water bodies In this way, this study has included detailed monitoring of the effect of the application of pig slurry at a concentration recommended on the chemical, physical and biological properties of soil, water and plant to determine the influence of slurry on the reserve of organic matter in each of these crops, as well as on soil contamination, through the creation of a pilot system for managing livestock waste. This system put in contact pig farmers and farmers to collect the stored slurry for their valorisation and land distribution, in accordance with preventive measures that allow for their optimal use, without risk of contamination for the water-soil-plant system.

Nowadays, anyone who has bought chemical fertilizer recently knows that the cost of fertilizer has increased in the last years. Phosphate prices have trebled over the past 12 months with the price of Potash following a similar trend.

For these reasons, the aim of the present study has been developed in order to give some economical advantages for farmers and pig farmers besides the sustainable management of slurry and organic soil amendment. In this way, the effects of nitrogen (N) fertiliser and slurry management practices in agricultural systems has been calculated based on three application dose: valorised slurry pig as the only fertilizer, valorised slurry pig + chemical fertilizer and only chemical fertilizer.

2 MATERIALS AND METHODS

The present 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 it has been selected 3 Farmers (F) and 3 Pig farmers (PF) according to the optimal distance between them.

Information about the farm management as well as crop cycles was collected by farmer's interview. Then, 10 points of sustainability were selected where samples of soil and slurry were taken before and after slurry application. Plant samples also were taken at the end of each cultural cycle depending on the crop.

The pig slurry application was made as an organic amendment soil before the crop cycle. The form of this application was in spreading band using a tanker. The N maximum dose of application is mandatory regulated (RD 261/1995) and established in 170kg ha^{-1} $year^{-1}$ in special sensitive areas. In this work the dose of valorised slurry to apply has been calculated based on N content. In this work it has been considered the lowest dose (170kg $ha^{-1}year^{-1}$) in order to avoid the risk of soil pollution.

The rest of the chemical fertilizers doses were applied following the rules reported in the NBPA (Good Agrarian Practices) as nutrients complement crop requirements.

The soils and pig slurries samples 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. 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. All the samples were analyzed by standard methods to obtain the texture classification for determining soil suitability for manure application according to the three fertilizer selected systems, values of total N (Duchafour, 1970), pH (Peech, 1965), electrical conductivity (Bower and Wilcox, 1965) and total P (Watanabe and Olsen 1965).

3 RESULTS AND DISCUSSION

At the beginning of the study, the farmers had to complete a questionnaire where they reported all the necessary information about the farm management (TABLE 1). In this questionnaire it is possible to find very important information like slurry application method (surface spreading or injection), application time or the additional use of chemical fertilizer.

The most important decision about slurry spreading concern is the selection of spreading date and choosing the fields which are likely to produce only moderate leaching effects (Lewis et al, 2003). In this study the application method was surface spreading in all cases, as well as the date of application was in autumn, before the crops cycle starts. Application of slurry in autumn (as a single or split loading), invariably leads to large losses through N leaching, with a single application always resulting in the highest loss. Significant differences are evident for N leaching from different soil types (Lewis et al., 2003). Also climatic variation produces noticeable and significant differences in both N leached and harvest crop totals (Lewis et al., 2003). Nevertheless, in this study the farm manager can recognise and match the soil type and drainage condition of the fields on which spreading is to occur, as all the soil samples are analyzed in order to identify the textural classes. But, as it is shown in TABLE 3 the predominant textural class is *Clay*, what means low permeability and decreased risk of N leaching. Other important advantage is that this study has been developed within a similar climate region.

TABLE 1 **Farming management and crop cycle information**

Farmer	Crop	Has	Chemical fertilizer cost (€)	Application time	Application method	Application dose(L/Ha/year)	Tanker capacity (L)
F1	broccoli	0,51	133,35	at the end of summer	surface spreadi	61000	10000
	artichoke	1,42	457,2				
F2	broccoli	3,04	802,56	all year	surface spreadi	50425	12000
	brocoli	2,37	625,68				
	brocoli	4,68	1235,52				
	brocoli	4,93	1301,52				
F3	brocoli	0,73	193,88	at the end of summer	surface spreadi	34000	12000
	brocoli	0,62	163,13				
	brocoli	1,05	272,2				
	brocoli	2,53	666,96				

The physic and chemical characterization of pig slurry (TABLE 2) showed that the changes produced in slurry pig nutrients composition, could be considered as a minimum variation due to changes in animal and farm management. Thus, this data allow calculate application dose according to the N content for both years. The additional amount of chemical fertilizers is applied, in each case, based on the published data in the current normative.

TABLE 2 **Physic and chemical data of pig slurry.**

Sampling Date	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
2008	PF3	33,80±0,42	7,31±0,06	97,26±0,32	3,31±0,42	5,05±0,17	207,00±33,05
	PF1	27,75±0,919	7,12±0,06	84,4±11,44	2,15±0,63	2,51±0,68	100,2±0,10
	PF2	55,10±0,1	7,79±0,01	92,22±1,07	6,33±0,01	4,58±0,25	290,7±0,29
2009	PF3	36,50±0,1	6,95±0,04	97,87±0,05	2,79±0,07	3,12±0,05	397,0±0,39

The results obtained in soil samples (TABLE 3) showed that the selected fields had optimal characteristics to agronomical use; the N and P content were lower than the published references values. Also is possible to see that the nutrient's content is higher at the surface level than at a depth of 30cm. This is due to the fertilizers application method, always by surface spreading, as well as the textural class (mainly Clay) (TABLE 3·). Even it is possible to see that the N content between years has suffered a minimum variation.

TABLE 3 **Soil data for 10 points of sustainability selected**

FARMER	CODE	SAMPLE	pH	EC(µS/cm)	TOTAL N 2008	TOTAL N 2009	P 2008	P 2009	Textural class
F1	F1-1	SL	7,22	578	1,471	1,098	360,83	529,21	Silt loam
		D30 cm	7,17	668	0,946	1,632	162,41	559,36	Loam
	F1-2	SL	7,15	1660	1,476	1,461	216,08	476,00	Loam
		D30 cm	7,48	316	1,012	1,220	98,72	461,43	Clay loam
F2	F2-1	SL	7,25	775	0,959	1,194	321,05	288,64	Loam
		D30 cm	7,38	2150	2,080	1,132	250,57	288,40	Clay loam
	F2-2	SL	7,23	1457	2,399	1,306	147,57	261,05	Loam
		D30 cm	7,34	1384	2,000	1,136	116,49	227,50	Clay
	F2-3	SL	7,23	1392	2,455	1,142	189,15	219,01	Clay loam
		D30 cm	7,36	1917	1,432	1,142	188,23	276,29	Clay
	F2-4	SL	7,12	1060	2,615	1,199	306,36	250,29	Clay loam
		D30 cm	7,4	1238	1,679	1,159	82,55	313,53	Clay loam
F3	F3-1	SL	7,33	816	1,186	1,079	861,89	418,44	Silty clay
		D30 cm	7,16	1039	0,983	0,954	514,10	413,84	Silty clay
	F3-2	SL	7,35	652	1,109	1,070	592,13	465,27	Silty clay
		D30 cm	7,13	1348	1,108	1,194	430,72	344,03	Silty clay
	F3-3	SL	7,34	910	1,007	1,068	470,00	619,85	Clay
		D30 cm	7,27	1301	0,662	0,656	317,92	299,72	Clay
	F3-4	SL	7,34	822	1,200	1,077	408,16	418,52	Silty clay
		D30 cm	7,26	767	0,900	0,974	308,91	349,52	Silty clay

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

In TABLE 5 it is showed the comparison between three fertilizers options in order to evaluate the optimal decision. Thus, following the main objective of this study, an economic analysis was carried out taking into account equipment costs, in this case the tankers used for slurry transport and spreading, and potential savings in costs of N, P and K mineral fertilizer. The fertilizer's cost has been calculated according to crop requirements that make the Integrated Production Technical Standards, published for these crops. The price for the tanker is the mean from different prices reported by farmers for several tanker capacities. On economic grounds, the use of tankers for surface spreading, could be justified in terms of fertilizer cost savings, because the additional costs of injection could be recouped in reduced fertilizer requirements, but comparing the results reported by others authors (McGechan and Wu, 1998) only half of the additional costs could be recovered in this way.

In spite of broccoli and artichoke were the evaluated crops, in TABLE 4 and 5 were presented the crops they had published data for technical management in Integrated Production Technical Standards (BORM Nº 138, 1998). Thus the estimation price has been adapted to the available crop information.

TABLE 4 **Nutrient uptake according to the crop cycle (based on INTEGRATED PRODUCTION TECHNICAL STANDARDS, BORM Nº 138, 1998).**

CROP	Production (kg/ha)	N(kg/ha)	P (kg/ha)	K (kg/ha)
Barley	2500	65	25	5
Lettuce	50000	100	105	5
Broccoli	20000	245	100	15

TABLE 5 **Economical data for three options of fertilizers evaluated**

CROP	Only chemical fertilizers(€/ha)	Only slurry pig(€/ha)	Slurry pig+chemical fertilizer(€/ha)
Barley	210	200	207
Lettuce	502	200	399
Broccoli	783	200	570

In view of economic performance the most important objective is to convince farmers that this system is very suitable fertilization and is well supported by legislation. In addition the system is perfectly enhanced with the addition of suitable chemical fertilizers.

4 CONCLUSIONS

The results of this study show that increasing rates of N applications (in the form of slurry and fertiliser) resulted in a non-linear increase before two years of study. And taking in account the economical conditions, we conclude that the mixed fertilizer option represented a saving of at least 50% compared to chemical fertilization, and taking advantage of liquid nutrients complement crop requirements that make the AIPG.

The repeated spreading of slurry on the same land area was shown to be a good practice from an economic standpoint, as well as being a sustainable option to manage the excess of manure. However, the economic and organisational feasibility of this system should be evaluated. Also, the content of others nutrients as a P, for example, should be further investigated.

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