STUDIA UBB AMBIENTUM, LXII, 1, 2017, pp. 43-51
(RECOMMENDED CITATION)
DOI:10.24193/subbambientum.2017.1.03

ASSESSMENT OF PHYSICO-CHEMICAL PARAMETERS OF SOILS IN ZOOTECHNICAL FARMS AREA FROM TICHILEȘTI AND TUFEȘTI LOCALITIES (BRĂILA COUNTY)

Eduard-Gabriel GHIORGHIU[1*], Delia GLIGOR[1], Ramona BĂLC[1,2]

[1] *Babeș-Bolyai University, Faculty of Environmental Science and Engineering, 30 Fântânele Street, 400294, Cluj-Napoca, Romania*
[2] *Babeș-Bolyai University, Interdisciplinary Research Institute on Bio-Nano Sciences, Treboniu Laurian 42, Cluj-Napoca, 400271, Romania*
** Corresponding author: ghiorghiu.eduard@yahoo.com*

ABSTRACT. Two growing-fattening pig farms – non-organic and organic - have been chosen in order to estimate the potential environmental impacts of heavy pig production. The above mentioned farms are situated in Tichilești-Tufești area, Brăila County, Romania. This area is situated in the north-eastern part of the Romanian Plain, which is delimitated by the Danube River in the southern part. Is one of the highest agricultural potential areas, reflected in a development of the economical sector based on zootechnical farms. Using the electrochemical methods, the nitrites and sulphides, from soil and water, together with physico-chemical parameters have been analyzed. The obtained results indicate the presence of the above mentioned chemical compounds in a small amount, excepting one location, situated near the organic farm. The maximum permissible limits imposed by the Romanian legislation are exceeded only for drinking water, being in normal values for all analyzed soil samples. In addition, a positive correlation between clay and nitrite/sulphides content can be observed.

Key words: *organic and non-organic pig farms, physico-chemical parameters, nitrites, sulphides, Tichilești-Tufești area*

INTRODUCTION

Considering environmental problems in Romania and across the world, significant changes have been occurring at zootechnical farm (Sutherland, 2011).

Intensive pig farming is usually concentrated in large production units, which increases the risks of air, water and soil pollution and represents a serious environmental problem. As could be expected, the environmental impacts of pig farming can be direct (due to the farming and manure management systems) or indirect (due to the impacts associated to produce inputs like feed and electricity).

The main pollution sources of pig farming arises from the production of crop based ingredients for feed production and from the emissions of methane (CH_4), ammonia (NH_3), carbon dioxide (CO_2) and hydrogen sulfide (H_2S) of pig housing and of the manure management systems (Gutierrez et al., 2016).

Nitrate (NO_3^-) can reach the underground and surface waters, increasing eutrophication and reducing drinking water quality. The EU Nitrates Directive 91/676 (EEC, 1991) requires member states (MS) to introduce measures to reduce NO_3^- losses to underground and surface waters from agricultural sources. The loss of nitrates can also contribute to indirect emissions of nitrous oxide, (N_2O) where NO_3^- is reduced into the underground and surface water bodies (Webb et al., 2014). Drinking water is also one of the major sources for nitrate/nitrite exposure. Nitrate is a source of nitrite due to it's endogenously conversion (Thomson et al., 2007).

The aim of this study was to highlight the difference between two types of pig farms - non-organic and organic - situated in Tichilești-Tufești area, Brăila County, Romania. The main objective was to evaluate the quality of environmental factors in the study area by determining the physico-chemical parameters (pH, redox potential, electrical conductivity, total dissolved solids, salinity, dissolved oxygen) and the concentrations of NO_2^- and S^{2-} in drinking water and soil samples.

MATERIALS AND METHODS

Study area

The studied area is represented by Tichilești-Tufești villages, located in the north-eastern part of the Romanian Plain, which is delimitated by the Danube River in the Southern part. This area has a very high agricultural potential (figure 1).

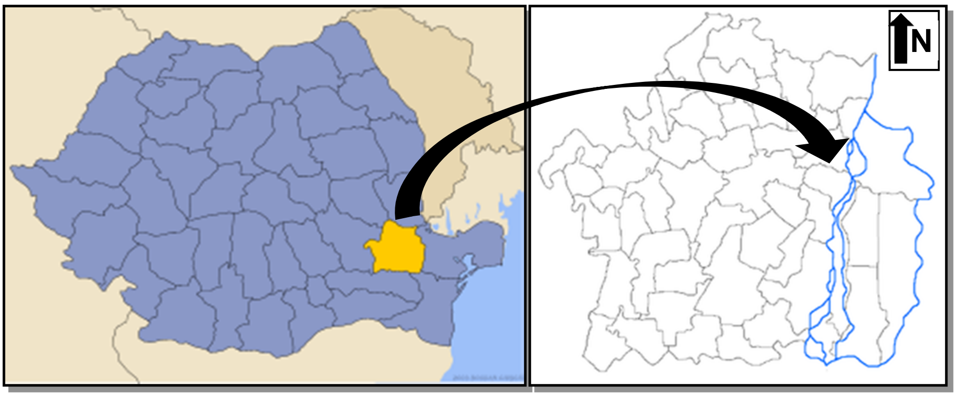

Fig. 1. *Location of the Tichilești-Tufești area on the (https://ro.wikipedia.org/wiki/Listă_de_comune_din_județul_Brăila)*

Total surface of the non-organic pig farm from Tichilești is about 175.240 square meters, while the organic pig farm from Tufești has a total surface area of 120.400 square meters. Both farms are delimitated by no.212 County Road in the western part and agricultural land in northern, eastern and southern part (figure 2).

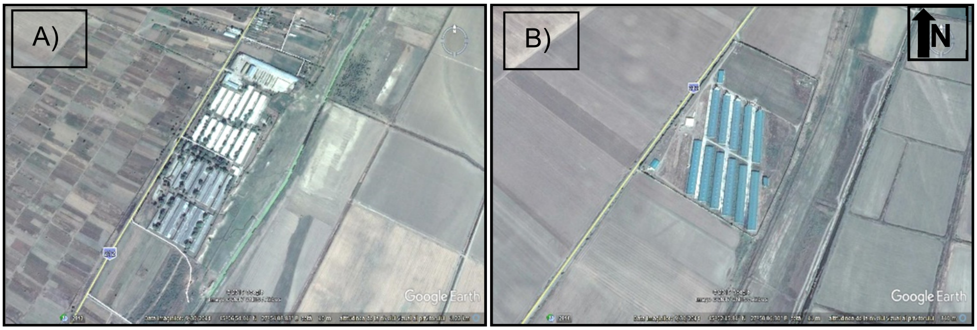

Fig. 2. *Location of the Tichilești non-organic farm (A) and Tufești organic farm (B) (GoogleEarth)*

A continental steppe climate with excessive influences and high thermal amplitudes characterizes the studied area. The average annual temperature is 11°C, summer average being 22.2°C. Annual relative humidity is 70% (in winter – over 80% and in summer – under 60%). Average annual precipitation does not exceed 450-500 mm during the summer, around 20 rainy days being registered (Ganea, et al., 2017).

Sampling and analytical methods

In order to evaluate the impact of the organic and non-organic growing pig farms, samples of soil and water have been collected using the methodology from the Order of the Ministry of Agriculture and Rural Development no. 278, published in the "Romanian Official Law Monitor" No. 928/28 December 2011 (OM 278/2011).

The soil physical parameters were determined according to the current national and international standard protocols, as follows: determination of organic matter - STAS 7107/1-76; determination of grain size-sedimentation and sift method - STAS 1913/5-85 and SR EN 14688-2:2005, and determination of free swell index of soil - IS-2720-PART-40-1970.

The physico-chemical parameters (electrical conductivity, salinity, pH, total dissolved solids) of the water and soil have been measured using a WTW Multi 350i multiparameter device. The electrochemical determination of nitrites (in water and soil) was performed using carbon paste electrodes (CPEs) modified with zeolite adsorbed with Toluidine Blue (CPE-Z-TB) and the sulphide determination used carbon paste electrodes modified with zeolite adsorbed with Methylene Blue (CPE-Z-MB). All electrochemical experiments were carried out using an AUTOLAB electrochemical analyzer (Autolab-PGSTAT10, Eco Chemie, Utrecht, Netherlands); all measurements were performed at room temperature.

The obtained sensors CPE-Z-TB and CPE-Z-MBs were used for the detection of nitrite and sulphide, respectively, using the standard addition method. In order to evaluate the pollution degree of the environment in the area and the potential effects upon human health, the concentrations have been compared to the maximum permissible limits imposed by Romanian legislation for drinking water (Law no.458 of 8 August 2002), and soil (Order no.756/3 November 1997) maximum limits issued by the US Environmental Protection Agency (US-EPA).

RESULTS

Physical parameters of the soils are characterised by the silty clay texture, with an adsorption capacity between 50% and 60%, excepting one sample with a clayey silt grain-size content having an adsorption capacity slightly larger (80%). Organic matter content is between 2% and 5% for most of the samples, overcoming 5% in one silty clay sample. A positive correlation between clay content and nitrites/ sulfides concentration can be pointed out as a general pattern. One exception appeared in the case of the sample with the highest content of nitrites/sulfides where the content of clay are not respecting this pattern.

The analyzed soil samples are included in the sensitive soils category, referring to the type of usage. The differences of physico-chemical parameters between non-organic pig farm and organic pig farm are not obvious (figure 3).

Physico-chemical parameters of the soil are characterised by the following values: pH between 7.7 and 8.1, the electrical conductivity between 156.8 and 185.1 µS/cm, salinity 0 ‰, total dissolved solids between 94.04 and 111.06 mg/L and redox potential between -72.8 and -57.3 mV. A correlation between electrical conductivity, total dissolved solids (TDS) and redox potential (Eh)can be observed. High concentration of the TDS have lead to a high electrical conductivity and also to a low redox potential.

Regarding NO_2^- level in soils, the average of all samples falls around 0.313 mg/kg (Fig. 3). A visible difference between the level of nitrites, between two analyzed pig farms, can be pointed out. Nitrites concentration in non-organic pig farm soils range between 0.206 and 0.222 mg/kg (average 0.214 mg/kg) while in organic pig farm varies between 0.260 and 0.558 mg/kg (average 0.379 mg/kg). Thus, the activity of the studied pig farms doesn't influence the quality of the soil due to the fact that the nitrite concentrations are low. It is necessary to mention that nitrites are not normalized by the Romanian legislation.

The concentrations of S^{2-} in soil samples are following the same pattern as nitrites concentration, a visible difference couldn't be noticed. The average concentration of S^{2-} in all samples is around 0.220 mg/kg except one value of 1.496 mg/l identified in one of the samples collected at the organic farm (figure 4). According to the Romanian legislation regarding the maximum limits allowed (MLA) for sulfides, the identified concentrations are falling into these limits.

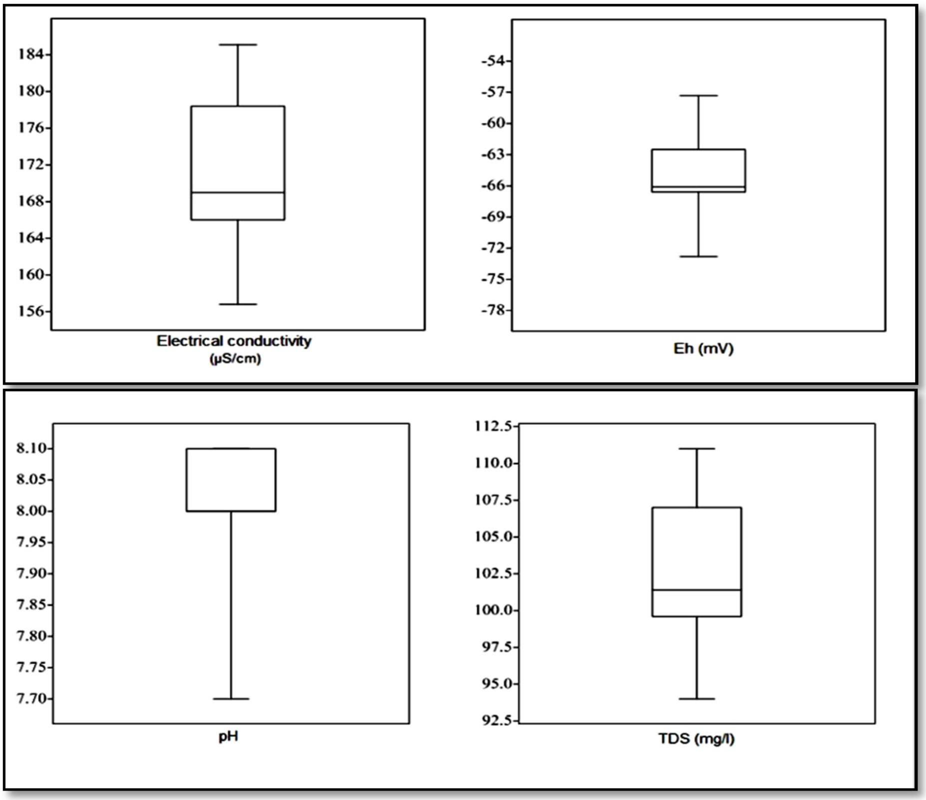

Fig. 3. *Physico-chemical parameters of soil samples*

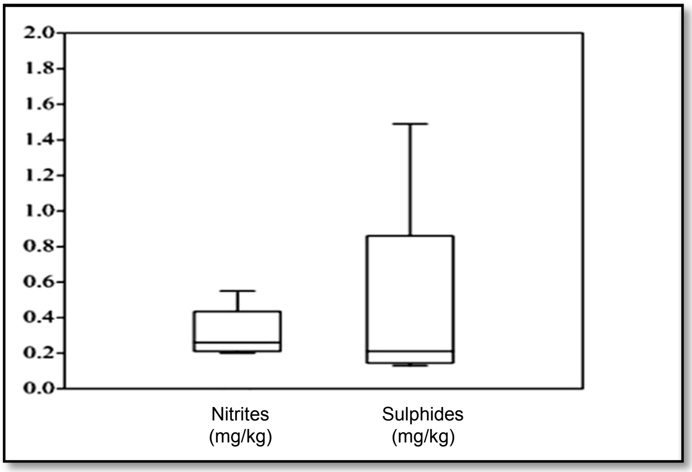

Fig. 4. *Nitrites and sulphides concentrations into the soil samples*

Regarding the drinking water samples, the concentration of nitrites are exceeding the MLA in one sample while the concentration of sulfides are exceeding these limits in all analyzed samples. The average values obtained for NO_2^-concentrations in drinking water is 0.290 mg/l with an exceedance of 0.518 mg/l (MLA 0.50 mg/l) and for S^{2-} the registered concentrations were361.5 µg/l (MLA 100 µg/l) (figure 5).

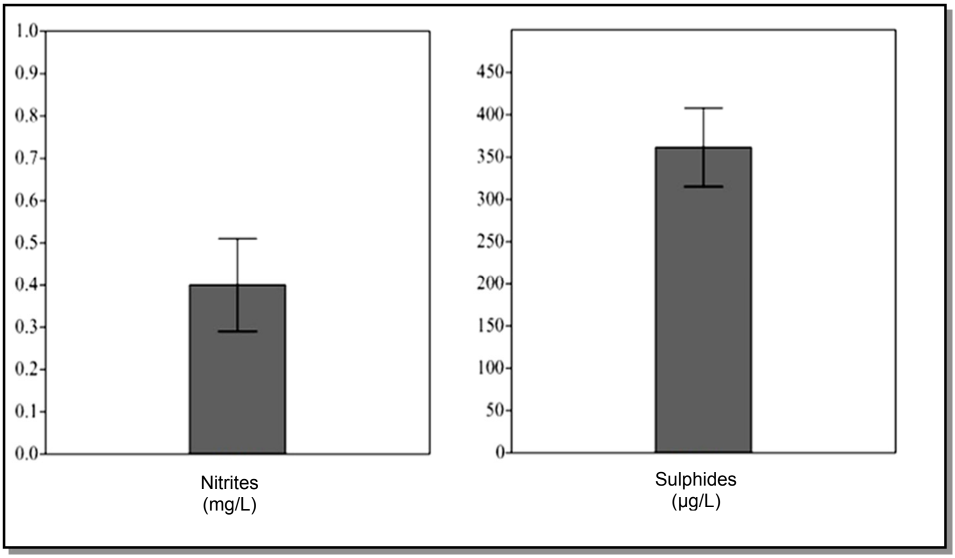

Fig. 5. *Nitrites and sulphides concentrations into the drinking water samples*

The physico-chemical parameters in drinking water are all in normal values according to the Romanian legislation no. 458/08.07.2002. pH between 7.55 and 7.86 (MLA 6.5-9.5), TDS between 864.6 mg/l and 2382 mg/l, salinity between 0.7 ‰ and 2 ‰, Eh between -39.5 mV and -58 mV, dissolved oxygen between 6.470 mg/l and 7.150 mg/l (MLA >5 mg/l) and an average value for electrical conductivity of 2705 µS/cm with an exceedance in one sample of 3970 µS/cm (MLA 2500 µS/cm) (figure 6). This exceedance pointed out the presence of a high dissolved salt content in water.

The obtained data indicates that the activity of the two analysed pig farms does not affect the soil but affects groundwaters, from nitrites/sulfides content point of view. Some other studies pointed out the exceeding of the MLA for many other chemical compounds (MST, CBO_5, CCO-Cr, SET, NO_3, NH_4, Nt, Pt, phenols) including the nitrites, in the case of the non-0rganic pig farms. In recent years many studies are focused on environmental impacts of organic farming (Cobb et al., 1999; Hole et al., 2005; Petersen et al., 2006; Wood et al., 2006; Sandhu et al., 2008) concluding that this type of agriculture offer environmental benefits, such as: an efficient nutrient cycles, an increasing of biodiversity across the farm, etc. These benefits are due to the fact that organic farming is characterised by the prohibition of the synthetic chemicals in both crop and livestock production (Lampkin, 2002). Instead, some other studies are contesting these benefits (e.g. Colman, 2000).

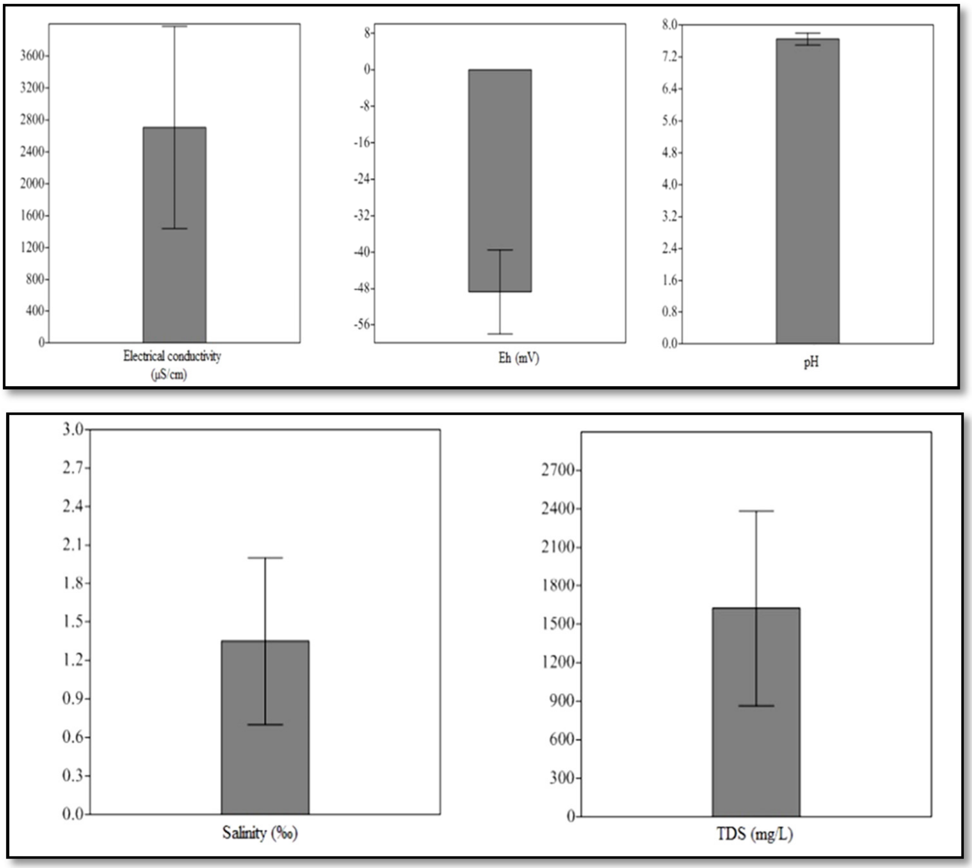

Fig. 6. *Physico-chemical parameters of drinking water samples*

To reduce the N excretion and NH_3 emissions, who can further pollute the soil and groundwater, farmers can adopt a series of best practices, such as changing the feeding system together with the reduction of crude protein content (Pirlo et al., 2016) and optimizing the amino acid profile in the different physiological phases (Xiccato et al., 2005). Thus, the role of feed chain in the environmental load of pork production is the most important factor regarding the impact on the environment together with farm size and reproductive efficiency (Bava et al., 2017. A source for sulf related compounds linked to pig production is the emission of hydrogen sulfide (H_2S) from pig housing and from the manure management systems (Stone et al., 2012; Reckmann et al., 2013). Thus, a proper management of the manure can be the solution to reduce the negative environmental impact (Vu et al., 2007).

CONCLUSIONS

In the current study the concentrations of NO_2^- and S^{2-} have been investigated in Tichilești-Tufești area. High levels of NO_2^- and S^{2-} were identified in all the drinking water samples investigated, exceeding the maximum permissible limits recommended by the Romanian legislation. However the concentrations of NO_2^- and S^{2-} in the soil samples were very low, being in the normal values recommended by the national legislation.

Considering the obtained results, the agricultural activity in the investigated area is not a source of pollution, from NO_2^- and S^{2-}concentrations point of view. To sum up, both farms have no significant environmental impact and do not represent a potential harm for the local community.

REFERENCES

Bava, L., Zucali, M., Sandrucci, A., Tamburini, A., 2017, Environmental impact of the typical heavy pig production in Italy. *Journal of Cleaner Production*, **140**, pp. 685-691.

Cobb, D., Feber, R., Hopkins, A., Stockdale, L., O'Riordan, T., Clements, B., Firbank, L., Goulding, K., Jarvis, S., Macdonald, D., 1999, Integrating the environmental and economic consequences of converting to organic agriculture: evidence from a case study. *Land Use Policy,* **16** (4), pp. 207–221.

Ganea, I. V., Roba, C., Gligor, D., Farkas, A., Bălc, R., Moldovan, M., 2017, Assessment of environmental quality in Lacu Sărat area (Brăila County, Romania). *Carpathian Journal of Earth and Environmental Science*, ***12*** (2), pp. 377-387.

Gutierrez, A.S., Eras, J.J., Billen, P., Vandecasteele, C., 2016, Environmental assessment of pig production in Cienfuegos, Cuba: alternatives for manure management. *Journal of Cleaner Production,* ***112*** (4), pp. 2518-2528.

Hole, D.G., Perkins, A.J., Wilson, J.D., Alexander, I.H., Grice, P.V., Evans, A.D., 2005. Does organic farming benefit biodiversity?, *Biological Conservation,* **122**, pp. 113–130.

Lampkin, N., 2002, Organic farming. Old Pond, Ipswich, 747 p.

Petersen, S., Axelsen, J.A., Tybirk, K., Aude, E., Vestergaard, P., 2006. Effects of organic farming on field boundary vegetation in Denmark Agriculture. *Ecosystems and Environment*, **13** (1–4), pp. 302–306.

Pirlo, G., Carè, S., Della Casa, G., Marchetti, R., Ponzoni, G., Faeti, V., Fantin, V., Masoni, P., Buttol, P., Zerbinatti, L., Falconi, F., 2016. Environmental impact of heavy pig production in a sample of Italian farms. A cradle to farm-gate analysis. *Science of Total Environment*, **565**, pp. 576-585.

Reckmann, K., Traulsen, I., Krieter, J., 2013, Life Cycle Assessment of pork production: a data inventory for the case of Germany. *Livest. Sci.***157**, pp. 586-596.

Sandhu, H.S., Wratten, S.D., Cullen, R., Case, B., 2008, The future of farming: the value of ecosystem services in conventional and organic arable land. An experimental approach. *Ecological Economics,* **64** (1), pp. 835–848.

Stone, J.J., Dollarhide, C.R., Benning, J.L., Carlson, C.G., Jinka, R., Clay, D.E., 2012. The life cycle impacts of feed for modern grow-finish Northern Great Plains US swine production. *Agric. Syst*. **106**, pp. 1-10.

Sutherland, L. A., 2011. "Effectively organic": Environmental gains on conventional farms through the market? *Land Use Policy,* ***28*** (4), pp. 815-824.

Thomson, B.M., Nokes, C.J., Cressey, P.J., 2007, Intake and risk assessment of nitrate and nitrite from New Zealand foods and drinking water. *Food Additives & Contaminants,* **24**, pp. 113-121.

Vu, T.K.V., Tran, M.T., Dang, T.T.S., 2007, A survey of manure management on pig farms in Northern Vietnam. *Livest. Sci*. **112**, pp. 288-297.

Webb, J., Broomfield, M., Stephanie, J., & Donovan, B., 2014, Ammonia and odour emissions from UK pig farms and nitrogen leaching from outdoor pig production. A review. *Science of the Total Environment,* **470-471**, pp. 865-875.

Wood, R., Lenzen, M., Dey, C., Lundie, S., 2006, A comparative study of some environmental impacts of conventional and organic farming in Australia. *Agricultural Systems,* **89** (2–3), pp. 324–348.

Xiccato, G., Schiavon, S., Gallo, L., Bailoni, L., Bittante, G., 2005, Nitrogen excretion in dairy cow, beef and veal cattle, pig, and rabbit farms in Northern Italy. *Ital. J. Anim. Sci*., **4** (3), pp. 103-111.