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STUDY OF ENVIRONMENT PROTECTION QUESTIONS AT MODERN PIG BREEDING

Florin DUMESCU*[1], Ladislau KLEIN[1], Dana Monica DĂNOIU[2]
[1]"Vasile Goldiş" Western University Arad, Romania
[2]Environment Protection Agency Arad, Romania

Abstract. Problems of pollution were studied at three pig breeding farms, built and started up during the last period. It was taken into account that waste water resulted in such farms or in meat processing is a potential raw material for being used in agriculture. The study took into account criteria such as preventing pollution by use of best available techniques, assuring efficient energy use and also that no important pollution will be caused, avoiding appearance of waste or if they appear neutralizing or reusing them. The study emphasized that the impact on environment is minimal and inside legal frame. Modern technology, the means used for waste treatment and reuse of waste result in minimal impact on environment. New technologies permit a circuit of useful substances and reusable components of wastes that become fertilizers. These farms demonstrate radical concept changes in breeding and in environment protection.
Keywords: breeding, pig, wastewater, soil, fertilizing,

NTRODUCTION

A retrospective analysis - Breeding, and that of porcine inside it, is a traditional human activity with old traditions in Arad County. Large pig farms were built and exploited beginning with the second half of the 20th century but that farms caused huge environmental problems. As a general, these farms were erected for using hydraulic discharge of dejections, followed by treating the wastewater by aeration, settling and stocking the resulted sludge for being valued as fertilizer. This type of technologies proved to be not reliable and also great consumers of investments and energy. These farms were not only constructed but especially exploited not in the best way and therefore they became not only important energy consumers, but also important sources of pollution. Such problems are registered also in usual, old municipal waste ponds (Dănoiu, Dumescu, 2010).

Wastewater as a reusable resource - Wastewater resulted in breeding or in meet processing are potential sources of valuable raw materials that could be used in industry or in agriculture (Beelitz et al., 1996). So protein content of such type wastewater is potentially usable as admixture to poultry fodder (Klein et al., 2004). Separating useful materials from wastewater resulted in meat processing for being used as admixture was studied in previous works (Klein at al., 1999). The researches carried out proved that the nutrients, namely proteins, recovered from wastewater resulted in meat processing have no negative effect on the health of the animals that consumed the fodder (Crăiniceanu al., 2000). Reducing pollution by valuing components of wastewater, namely recovery of protein components is object of profound studies (Klein et al., 2002).

At the same time technologies in breeding as a general, and in pig breeding as a special, developed to a better use of nutrients contained in fodder, to a better use of buildings and to reducing the amount of the resulted waste and their effect on environment. The case of new farms, started up during the last years, demonstrates that pig breeding farms can be erected, built and exploited such way that they assure the required products without affecting environment more that it is allowed.

MATERIAL AND METHOD

Environment protection questions at modern pig breeding farms are studied, analyzed and discussed using the experience and the laboratory results existing in farms situated in Arad County.

RESULTS AND DISCUSSION

General presentation - Pollution problems were studied at three farms specialized in pig breeding. The farms, started up during the last period, are situated in Gurba, Cermei and Sintea Mare rural localities and owned by a company with headquarters in Timisoara. The study took into account provisions of the Romanian Environment Protection Law and regulations connected to that law, regulations cited at the Literature chapter of the present work. The study took into account criteria such as:

- efficient prevention of pollution by using the best available techniques;
- assuring that not any important pollution will be produced;
- avoiding to produce waste, and if this is not possible, using that wastes, or, if technically not possible, neutralizing them to avoid or reduce impact on environment;
- efficient use of energy;
- preventing accidents and reducing their effect if they take place;
- in case of shutting-down, preventing any possibility of polluting and creating conditions for normal reuse of the land.

Correspondence: *Florin Dumescu, "Vasile Goldis" Western University Arad, Faculty for Economics, 15 Eminescu Str., 310086 Arad, Romania, tel. 0040257213066, fax 0040257243777, e-mail: marketing@uvvg.ro*

Each of the farms has the same maximal capacity, namely 8.160 heads/series, and the yearly production per farm is 16.320 heads. The number of heads/series is equal to the number of available places in the farm. The materials used in the farms are comprised in the table 1, and the water and energy resource in the table 2.

Table 1.

Materials used in the farms

Materials	Impact on environment	Way of packing and storing
Combined fodders	No impact on environment	Two metal bunkers/building
Water for watering, cleaning spaces, household type use	No impact on environment	Underground water, extracted by drilling
Liquefied petroleum gas, for incinerator and for heating	Nominated as being a dangerous substance	2x2x5000 m^3 standard tanks on concrete platforms
Diesel oil, for the electro group	Nominated as being a dangerous substance	230 liter reservoir
Medicines and vaccines for the animals	No impact on environment	Temporary storage in a closed storehouse
Materials for hygiene and dis-insecting	No impact on environment	Temporary storage in a closed storehouse

Source: self processing

Table 2.

Water supply for Gurba farm (identical for Cermei and Sintea Mare)

	Water supply for hygienic-sanitary and technological purposes
Source	Two wells, 143m and 146m depth respectively
	Authorized flow
Daily max.	102,47 m^3/day
Annual volume	21217,45 m^3/year
Water norm	2 – 4 l/day for young animals, 10 l/day for animals during feting
Function time	365 days per year, 24 hours per day
Pumping	Electro-pumps, 600l hydro fore
Piping	High Density Polyethylene
Storing	None

Source: self processing

Table 3.

Wastewater discharge – Gurba Farm (it is the same for Cermei and Sintea Mare)

Water category	Authorized receptors	Total discharged volume			Remarks
		Maximal m^3/day	Average m^3/day	Annual thousands m^3	
Technologic waste water	First two metal basins, 5.000 m^3 each , then fertilizing agricultural terrains	46.98	39.15	14.10	Organic fertilizing
Household waste water	10 m^3 empty able basin	0.20	0.17	0.073	Contract with local authorities

Source: self processing

The total length of waste water pipes and collectors is 450m. No waste water treatment stations exist. Rainwater flowing from the roofs is infiltrated into the soil.

Energy supply - For all of the farms electric energy used for lighting and for machinery acting, such as pumps and fans, is obtained by connections to the national electro-energetic system. For this each farm has a 250 kVA sealed transformer without oil vat. For emergencies Diesel oil acted generator groups are provided.

Heat producing points for each farm are fed from 5000l LPG (liquefied petroleum gas) tanks. That points heat the sanitary filter in each of the farms, using 8.5 kg/h LPG and evacuating the resulted gases through a 3.10 m high and 300 mm diameter chimney.

There is an annual plan for efficient use of energy and an audit for energetic efficiency.

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EQUIPMENT AND TECHNOLOGY IN FARMS

Gurba Farm

a. Endowment - Gurba Farm is situated outside Gurba locality, 3 km far from the last household. Around the farm there are terrains agriculturally used. Also the field on which the farm is placed had an agricultural use in the past. The access to the farm is made of broken stone treated with bitumen, while that to the stocking reservoirs a ground one.

The total surface of the farm is 123.940 m^2 8.944 m^2 being covered by buildings, roads and concrete platforms. Green spaces are extended on 112.074 m^2.

Dead bodies are incinerated in two devices having capacity of 500kg per charge. In their surrounding, placed on concrete platform, there are the cooling chambers and the necropsy spaces. The cooling chambers of 2.7 x 3.42 m are used for temporary storing of dead animals; they are suited with cooling devices with ecologic Freon. The leakages are collected together with those of the necropsy chamber in a 2 m^3 basin. These areas are disinfected, disinsected and cleared of rats using the same substances as for the same operations in the farm.

b. Technology - *Shelters and their cleaning, collecting and removing dejections*

To shelter animals four identical buildings were erected two of them being heated and two cold ones. The worm ones, 1670 m^2 each, can host 2x4080 young sows of 7 – 28 kg each assuring 0.35m^2 per animal, or 2x2040 adult pigs of 28 – 110 kg each, 0.75 m^2 for each of them. Such way the European Directive 91/630/CEE for the minimal conditions concerning pork breeding is observed. The cold buildings have the same dimensions and are destined for adult animals observing the above mentioned norms (Directive of the European Community Council for establishing minimal pig protection norms 91/630/CEE).

The warm buildings are situated between the cold ones. Each of the buildings designed for animal hosting is constituted of 16 boxes and one hospital box. The boxes of the cold buildings and of the cold part of the warm buildings are provided with holes situated above the dejection collecting canals. The warm areas situated centrally inside the warm boxes have no grating, but warm water coils, such way they are the rest place for young sows.

Hosting systems

Hosting in the warm buildings is suited with two types of climates during the first five weeks, when heating is assured by ceramic radiant bodies. Manure is handled as a mixture of dejections. The channels are emptied through lids. Channels are emptied after moving away the series of pigs at the same time with hygiene the boxes.

Hosting in the cold buildings is achieved with flooring entirely covered by grids. Manure is handles as mixture as described above.

Cleaning the boxes

Cleaning and assuring hygiene of buildings are achieved at the end of a production cycle. Washing is done with a device using high pressure water and biodegradable detergents. The resulting wastewater is collected in the waste basin. The last rinsing water is retained in the channels for being the water puffer for the following production cycle.

Heating the production buildings

Heating is achieved by the use of radiant ceramic bodies. Supplementary four heating bodies using liquefied petroleum gas are in each building. If necessary the warm buildings can be heated as well. No chimneys are necessary.

Ventilation of the buildings

The suitable climatic conditions are assured by a computer led automatic system. The outside walls of the buildings are provided with ventilation holes with impregnated curtains that can be automatically lifted or let down according to the temperature and humidity. On the ceiling there are 16 natural draught exhausting devices per building and they discharge foul air through metal chimneys. The warm buildings have also a forced exhausting system. For this purpose on each building there are further 28 fresh air admissions and sixteen 13.800 m^3/h exhausting devices fixed in the ceiling and evacuating air through metal chimneys.

Collecting and transfer of dejections

Collecting channels are longitudinal disposed and they are divided into four compartments. Such way each compartment can be emptied independently. The water layer in collectors has an average depth of 3 - 5 cm. The water resulted in washing inside the building is removed through the dejections cannels. There are four such channels in the warm buildings and five in the cold ones.

Outside canal system

The wastewater removed from buildings and the dejections are collected by the outside channel system. That system is placed in the green area of the farms, on sand beds. Discharging of wastewater from this system is achieved by a pump station equipped with a pump in a concrete basin. The pump starts up automatically in case of damage.

Stocking of dejections

To store the dejection for fermentation for about six month long two 5.000 m^3 metal basins with homogenizers are inside the farm. The basins are emptied into the transport cistern that stays on a concrete platform. The six month storage is necessary to assure fermentation.

For incineration of dead bodies two devices with capacity of 500kg/charge are placed on a concrete platform that allows communication with the inside space. The secondary chamber of the incinerator achieves 850^{o}C for two seconds, allowing a complete burning. The incinerator has a 3m high 300 mm diameter chimney that allows good dispersion. The incinerator consumes 10 –

12 l/h liquefied gas that is stocked in two reservoirs 5.000 l each.

Other activities

Discharge of food from tracks to the external bunkers, discharge of animals coming to the buildings and loading animals for transport, inside transport, maintenance, and administration are supplementary activities carried out inside the farm.

The farm is erected such way that an "all full, all empty" management is possible – preparations begin just after the last animal leaves the compartment. Preparation begins with a mechanical removing of dejections. Washing is achieved by use of high pressure pumps, followed by disinfection and disinsection of the area.

Cermei Farm

This farm is placed outside the locality at about 3km far from the last household. Around the farm there are agricultural fields. The total area of the farm is 81.200 m^2 8.944 m^2 being covered by buildings, roads and concrete platforms. Green spaces are extended on 74.289 m^2. The previous use of the area was agricultural.

The design and use of buildings and of the annexes is the same as they are at the already described Gurba farm.

Sintea Mare Farm

The Sintea Mare farm is placed on the administrative territory of Sintea Mary locality, outside the village, at about 3 km far from the last household. Round the farm, on about one km distance, there are only fields with agricultural use. The total surface of the farm is 5.28 ha. Its previous use was agricultural.

The design and use of buildings and of annexes is the same as they are at the already described Gurba farm.

Devices for retaining, removing and dispersion of pollutants

All the described farms are provided with devices of the same type for retaining, removing and dispersion of pollutants.

a. Dispersion to the air

Emissions to the atmosphere are generated in metabolic processes, in dejection management, dead body incinerating and annex activities such as transports, fodder discharges, maintenance of the farm area. Emissions are discharged from the production buildings and from dejection storage where anaerobic fermentation takes place. Also ammonia, methane, nitrogen oxide emissions results in spreading out dejections on the field. Using the best techniques and practices in hosting animals and in dejection handling minimizes emissions.

Table 4.

Emissions to the atmosphere

Source of pollutants	Emission point	Pollutants	Necessary measures to reduce pollution	Continuously measured pollutants
The incinerator	Dispersing chimney	Solid particles; CO_2; SO_2; NO_2; HCl; HF; organic substances; heavy metals and their compounds	No equipment to avoid pollution is necessary	Monitoring is not necessary

Source: self processing

b. Pollutant emissions to water

There are no discharges to surface or underground water. The wastewater problems are solved as follows, the result being that no wastewater discharges are into natural flows or into groundwater:

-technologic wastewater such as liquid dejection and wash water are collected in basins and afterwards they are used for fertilizing;

-household wastewater is collected in an empty able 20 m^3 basin;

-rainwater is absorbed into the soil, it is not polluted;

-wastewater resulting in the necropsy area and in the cooling chamber is collected in an empty able 20 m^3 basin;

The empty able metal on ground basins are correctly water-tighten.

c. Soil

For protecting soil household garbage is separately collected and stored and the above mentioned wastewater basins are placed on concrete platforms.

d. Other equipment

For auxiliary materials used in disinfection and disinsection a closed store house exists.

Concentrations of pollutants discharged into the environment

Values of pollutant concentration discharged into the environment are inside the values of legal regulations.

The air

a. Emissions

Values for emissions are comprised in the table 5 and they observe the legal regulations.

Table 5.

Maximal values addmitted for emisions to the air

Source of pollutants	Pollutants	Emission point	Maximal values
The incinerator	Powders	Chimney	10 mg/Nm^3
	Organic substances as gases or vapors, expressed as total organic carbon		10 mg/Nm^3
	CO_2		50 mg/Nm^3

Source: self processing

b. Imissions

Values for pollutant imissions are inside the values comprised in the Romanian standard for air quality, namely STAS 12574/1987 (table 6).

Table 6.

Imissions, short time average values (30 min)

Indicator	Value
Nitrogen dioxide	0.3 mg/m^3
H_2S	15 mg/m^3
Ammonia	300 mg/m^3

Source: self processing

Table 7.

Imissions, long time average values (daily)

Indicator	Value
Nitrogen dioxide	0.1mg/m^3
H_2S	9 mg/mg/m^3
Ammonia	100 mg/mg/m^3

Source: self processing

Water - The wastewater discharged into the treatment plant of the locality presents indicators inside the values specified in the Romanian regulations (NTPA 002).

Table 8.

Indicator	Unit of measure	Maximal values
pH		6.5-8.5
Ammonia	mg/l	30
Chemical Oxygen Demand	mg $O_2$2/l	500
Biochemical Oxygen Demand after 5 days	mg $O_2$2/l	300
Suspended materials	mg/l	350
Nitrates	mg/l	-
Nitrites	mg/l	-
Extractible substances	mg/l	30

Source: self processing

Pollutants concentrations in the underground water in the farm area have to be inside the values obtained for the witness sample and this requirement is really fulfilled. The indicators taken into account are pH, concentrations in ammonia, nitrites, nitrates, chlorides, total organic carbon, phenols, phosphates, oxydability, and chemical oxygen demand.

Soil - Concentrations of specific pollutants in soil inside the farms and in soils where dejections are spread out are inside the legally established values, namely the organic carbon content 0 – 1%, total nitrogen content 21 – 60 mg/kg, neutral pH (6.8 – 7.2). The total amount of organic fertilizers does not exceed 170kg per hectare and year, this being in accordance with the Code of Best Agricultural Practice. The maximal amount is spread out when less fermented manure is used on heavy soils (clay) or on soils with high de-nitrification potential. Also this way of usage is applied for cultivation with long vegetation period or with high nitrogen consume. Materials are handled on special areas, on concrete platforms to prevent leakages to the soil.

Noise - Noise at the farm limit is inside

the provisions of the regarding Romanian standard STAS 10009/1988, namely max. 65 dB.

Reek - According to the valid standards regarding quality of air in protected areas, highly reeking emissions are over the permitted limit when reeking persists and it is perceivable by people. Therefore activities that involve persistent reeking are programmed for periods when vertical dispersion of pollutants is assured by the atmospheric conditions and also when transport of smells on long distances is avoided.

Hygiene during processes inside the farms is assured and manure removing program is severely observed.

Waste management - Waste is managed according to the laws in force (Direction nr. 242/2005, table 9). According to those laws producing of wastes is forbidden but if avoiding wastes is not possible they must be valued or, at least, the wastes must be neutralized or destroyed. Anyhow, impact on the environment must be avoided. These duties are fulfilled in the analyzed farms.

Temporary storage of wastes is assured on special protected areas. The transport of waste for being valued or destroyed outside the farms is done according the laws, without impact on environment.

Table 9

Waste management

No.	Waste denomination	Hazardousness according to legal prescriptions	Waste management		
			Storing	Valuing	Removing
1.	Dejections	Non hazardous	Collected in gutters inside the buildings, than stocked in basins	Fertilizing agricultural fields	-
2.	Pig corpses	Non hazardous	-	-	Incinerated in devices owned by the farm or sent for processing to a specialized company
3.	Household wastes	Non hazardous	Collected in special containers	-	Authorized deposit
4.	Glass flacons of vaccins	Dangerous	Temporary stored	-	Incinerated at authorized units
5.	Disinfected plastic package material	Dangerous	Temporary stored	-	Incinerated at authorized units
6.	Cardboard	Non hazardous	Temporary stored	By authorized agents	-
7.	Incinerator ash	Non hazardous	Stocked is covered recipients	-	Removed to an authorized waste storage place

Source: self processing

The dead animals are temporary stored in the cooled chambers and they are removed according to the legal norms. The incinerators are used only for the animals dead inside the farm.

Dejections are handled according to the "Code of best agricultural practices". General rules for fertilizing are observed and, for instance, the distance of 5-6 m to water flows in case of using solid fertilizers, 30 m in case of liquid fertilizers and 100 m in case of drink water wells to be protected is observed. Organic fertilizers use is avoided during rain, snowfall, or hard sun shining. Also they do not use such fertilizers on soils with an excess of water, on snow or frozen area. Dejections are used as fertilizers only after being chemically and biologically analyzed.

Water protection on the surrounding terrains which could be affected by pollution due to drainage water is assured. The rule according to which this type of fertilizing is not allowed on sloping terrain is observed. The chronology of fertilizing is evidenced in registers at the agricultural farms.

Toxic and dangerous substances administration - The following substances that are considered to be dangerous are used: liquefied propane, gasoline, disinfectants, and for all of them the administration rules are known and observed.

Safety rules and management of emergency situations - An analysis proves that the studied farms do not present major accident danger involving dangerous substances. However emergencies inside the farms can occur due to fire. To prevent them and to act in case the farms have the necessary equipment and also a program foe preventing and fighting fire. Also a plan to prevent and fight accidental pollution exists in each of the farms. As the main source of potential pollution is collecting, storing, transport and use of dejections, a program for their management exists in each of the farms.

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Monitoring the activity - Monitoring the pollutant emissions and the supervising the environment in the area of the farms is achieved by the own laboratory of the farms, but also by other laboratories for some of the indicators for which the farms have not the suitable equipment.

Also the quantity of raw materials, of water, energy and fertilizers used by the farms, as well as the resulted waste, the eventually occurring pollutions, the maintenance and the repairs, the personnel training are monitored. It is to be underlined that until now no environmental incidents were registered.

For the air half year monitoring is achieved regarding ammonia, nitrogen dioxide, H_2S and an annual one for the emissions resulted at the incinerator regarding dust, carbon monoxide, organic substances.

For water the basin of the necropsy area is monitored as regards pH, ammonia, chemical and chemical oxygen demand, suspended materials, nitrites, nitrates, extractible materials.

Underground water is monitored each half year in the area of dejection storing basins, and in the area of spreading the dejections. pH, ammonia, oxidability, nitrites, nitrates, total organic carbon chlorides, phenols, chemical oxigen demand, PO_4 are determined.

Monitoring of soil is achieved inside the farms, once a year, in the area of dejection stocking basins, and also on the agricultural fields where fertilization with dejections takes place. On the fields where dejections are spread out an annual agrochemical and pedological study is carried out that leads to a fertilizing plan. Yearly organic carbon, total nitrogen and pH determinations are carried out.

It is to underlie, as a positive option, that fertilizing with dejection is achieved only after the storing period necessary for fermentation/stabilization.

CONCLUSIONS

The study achieved on the activity carried out at the three pig breeding farms shows that impact on environment is minimal and inside the legal limitations. Modern breeding methods and the pollutant removing means that are used in the studied farms resulted in a minimal impact on environment. They demonstrate the progress achieved in this field during the last two decades so as regards breeding as regards technologies for removing pollutants just in the places where they appear. Even more, so as in food industry, as already underlined in the paper, some wastes are source of valuable raw materials, here too wastes can be returned into production without polluting danger, but with suitable care.

The new technologies permit assuring a circuit of useful substances, of the reusable components of wastes. In this case it is the question of use of dejections as natural fertilizers in conditions of total safety. And not lastly, this farms and this study demonstrate a radical change in concepts so in zootechny as in environment protection.

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