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MONITORING OF DAIRY FARMS TO ASSESS THE POTENTIAL LEVEL OF POLLUTION OF ANIMAL FEED AND ANIMAL PRODUCTION

Mădălina MATEI, Ioan Mircea POP

Iasi University of Life Sciences "Ion Ionescu de la Brad", 3 Mihail Sadoveanu Alley, Iasi, Romania

Corresponding author email: matei.madalina55@yahoo.com

Abstract

The over pollution in recent years has meant that the relationship between animal husbandry and the environment to be approached in the light of a sustainable vision, focused on animal welfare and ensuring the safety of feed and animal production. Given the influence of pollutants on the environment, this paper aims to outline the relationship between animals and environmental pollution, for assessing the potential level of pollution of feed and animal production. Thus, by correlating with the data from the literature, for three dairy farms, located in different geographical areas, was assessed, by observation and questionnaires, the specificity of activities in relation to monitoring feed and milk pollution. Following the monitoring and application of the evaluation questionnaire, the particularities of each farm and also the specifics of feed within them were highlighted, obtaining important information which allowed the assessment of the relationship between environment and animal husbandry, all of this for evaluating the potential level of pollution of feed and animal production and for classification of the studied farms by expected level of pollution: S - low; M - medium; R - high.

Key words*: animal production, environment, feed, pollutants.*

INTRODUCTION

The current situation regarding the level of global pollution has emphasized more than ever the interest for the environment, for human health and also for animal welfare. Despite numerous global measures to reduce pollution, harmful emissions released into the environment continue to cause important damages to soil, crops, animals or people (EEA, 2017).

Raising animals according to rational principles, in optimal and effective conditions, as well as the level of animal productivity, highlights particularly the influence of feed in their development (Mitchell, 2007). However, the process of rational animal husbandry involves a combination of some complex actions, focused on the growth and on the development of animals as a result of ensuring a nutritionally balanced diet and on ensuring the safety of feed and maintaining a harmonious relationship between the animals and the environment, which needs to be kept balanced and healthy.

As for the other trophic elements, the environmental pollutants can be harmful for the feed and dangerous for the animal body and also for the animal production. Despite many efforts to reduce pollution, however, pollutants remain dynamic compounds in the environment and can be a real threat to all the elements of the environment, forming a continuous cycle of contamination, from the soil, to vegetal products (animal feed), to animals and their productions and to human body (Nica et al., 2012; Manciulea & Dumitrescu, 2016).

In relation to the environment, pollutants can have important negative effects on crops (inhibiting the development of plants), on animals (metabolic disorders, decreased productivity, qualitative degradation of animal production) (Wielsoe et al., 2017), while on humans, pollutants can have a strong toxicity (Desiato et al., 2014).

In the production chain, the vegetal products used as feed may be exposed to contamination as a result of the absorption of harmful compounds from the soil or as a consequence of various human activities, such as industrial production, transport or agricultural activities (Rychen et al., 2008; Ukaogo et al., 2020). In terms of of animal production, the contamination may be a consequence of consumption of contaminated feed (EFSA,

2005; Rychen et al., 2008; Tao et al., 2009) and of metabolic transfer of pollutants stored in the animal body to the production obtained (Aytenfsu et al., 2016).
In the literature, different proportions of pollutants have been identified by studies, both in vegetal products used as feed (Albu et al., 2007; Dai et al., 2016; Piskorska-Pliszczynska et al., 2017; Tahir et al., 2017; Bedi et al., 2018; Miclean et al., 2019), as well as in the animal production obtained (Ahmadkhaniha et al., 2017; Chen et al., 2017; Lapole et al., 2017; Marin et al., 2020).
For these reasons, the purpose of this paper is to monitor the activities and the organization of feed bases in some dairy farms, in relation to environmental pollution, in order to assess the potential level of pollution of animal feed and animal production obtained (milk), necessary for a future quantification of the potentially pollutants found.

MATERIALS AND METHODS

According the specificity of the study and its associated purpose, the assessment of the potential level of pollution of feed and milk was carried out by monitoring, during 2021, three dairy farms (A, B, C), of different sizes (between 40-390 animals), selected depending on the level of pollution expected in their geographical area: A - mountain area; B - rural area; C - urban area (Figure 1).

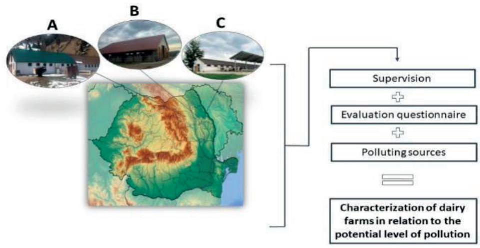

Figure 1. Farm monitoring stages

The characterization of the farms and the identification of the most relevant aspects in terms of production activity and ensuring the fodder base, in relation to monitoring feed pollution and animal production pollution (Table 1), was achieved through a combination of three actions which included:

- direct supervision and observation of the specific activities carried out on the farm;

Table 1. Farm monitoring questionnaire

Farm monitoring		Relevant information obtained
The specifics of the farm and livestock	Geographical location (type of settlement*, geographical coordinates, climate)	Correlation between geographical location and the climatic conditions (temperature, wind direction)
	Polluting activities in the vicinity of the farm	Identification of the main sources of pollution
	Herds, breeds and daily milk production	Assessment contaminated milk production
	Raising system; type of animal shelter; the milking operation	Assessment of direct exposure to pollution and of the possibilities of accidental contamination
Specific alimentation	Types of feed and structure of ration	Identification of the administered feed
	Free grazing	Assessment of direct exposure to pollution
	Number of meals administered	Frequency of possible contamination
	Feed administration	Assessment of the possibilities of accidental contamination
	Adaptation of the ration according to the physiological status of the animals	Correlation of physiological status with the action mechanisms of pollutants
The feed base	Feed origin (own production)	Assessment of pollutant traceability
	Quality analysis of feeds	Characteristics of feeds
	Harvesting, processing	Assessment of the possibilities of accidental contamination
	Crops: applied treatments and rotation	Possible contamination in terms of used fertilizers
	Feed storage	Assessment of direct exposure to pollution
Water	Unconventional water sources	Assessment of external pollution sources
Other information	Animal and shelter care / Substances used	Assessment of the possibilities of accidental contamination

**rural / urban*

- taking specific information on the activity of the farm, the feed base and the specifics of the feed using evaluation questionnaires developed in accordance with the data found in the literature;
- identification of pollution sources in the vicinity of farms and correlation of information found with data from the literature.

RESULTS AND DISCUSSIONS

Following the monitoring and application of the evaluation questionnaire, the particularities of each farm studied were highlighted, as well as the specificity of the animal feed within them (Table 2). Were obtained valuable information to assess the level of potential pollution of feed and animal production and for the classification of the three farms by pollution levels.

The information about the breeding system of animals and also the organization of the activity of the farms highlighted in general important differences between the three farms analyzed, especially in terms of the complexity of the activities developed in the farm. The differences highlighted focused on the characterization of farm A as having a lower pollution potential because, compared to farms B and C, where animal husbandry is carried out at an intensive system, in farm A a semi-intensive breeding and maintenance system was highlighted, which showed that it has the lowest operating capacity and the lowest degree of technology, therefore lower pollution risk.

Table 2. Information obtained by assessing the specificity and organization of the feed base in the monitored farms

<table>
<tr><td rowspan="2"></td><td colspan="7">Farms</td></tr>
<tr><td colspan="3">A</td><td colspan="2">B</td><td colspan="2">C</td></tr>
<tr><td rowspan="3">Geographical location (type of settlement*, geographical coordinates, climate)</td><td colspan="3">Mountain* area</td><td colspan="2">Rural* area</td><td colspan="2">Urban* area</td></tr>
<tr><td colspan="3">47°34′N - 25°19′E</td><td colspan="2">47.2134° N - 27.5066° E</td><td colspan="2">47°09′11″N - 27°39′41″E</td></tr>
<tr><td colspan="3">temperate, baltic and east-continental influences
wind direction - variables</td><td colspan="2">temperate - continental
wind direction: NW – SE
humidity: 63-84%</td><td colspan="2">temperate - continental
wind direction: WNW
humidity: 60-81%</td></tr>
<tr><td rowspan="3">Polluting activities in the vicinity of the farm / Generated pollutants</td><td colspan="3" rowspan="2">Stationary sources:
former mining area</td><td colspan="2" rowspan="2">Mobile sources:
air pollution</td><td colspan="2">Stationary sources:
chemical and steel industry</td></tr>
<tr><td colspan="2">Mobile and surface sources:
road and air transport/ POPs</td></tr>
<tr><td colspan="7">Agricultural activities: chemical treatments applied to crops / OCP</td></tr>
<tr><td rowspan="3">Herds, breeds and daily milk production</td><td colspan="3">40</td><td colspan="2">55</td><td colspan="2">390</td></tr>
<tr><td colspan="3">Brown Swiss;
Romanian Black Pied</td><td colspan="2">Fleckvieh</td><td colspan="2">Holstein Friesian;
German Black Pied</td></tr>
<tr><td colspan="3">12 L / day</td><td colspan="2">20 L / day</td><td colspan="2">25 L / day</td></tr>
<tr><td rowspan="2">Raising system; type of animal shelter; the milking operation</td><td colspan="3" rowspan="2">Stall–related maintenance in closed shelter;
Pasture - free maintenance in closed shelter
Milking system:
mechanical, individual</td><td colspan="4">Stall - free maintenance in closed shelter</td></tr>
<tr><td colspan="2">Milking system:
Mechanical, 8 seats /2 rows</td><td colspan="2">Milking system:
Mechanical, 32 seats /2 rows</td></tr>
<tr><td rowspan="9">Types of feed and structure of administered ration</td><td colspan="2">Type of feed</td><td>% of ration</td><td>Type of feed</td><td>% of ration</td><td>Type of feed</td><td>% of ration</td></tr>
<tr><td rowspan="5">Cold season ration</td><td rowspan="2">Natural hay</td><td rowspan="2">50</td><td rowspan="2">Corn silage</td><td rowspan="2">56</td><td>Corn silage</td><td>45.45</td></tr>
<tr><td>Alfalfa silage</td><td>10.9</td></tr>
<tr><td rowspan="3">Corn silage</td><td rowspan="3">50</td><td rowspan="2">Alfalfa hay</td><td rowspan="2">22.4</td><td>Alfalfa hay</td><td>5.45</td></tr>
<tr><td>Brewers grain</td><td>18.18</td></tr>
<tr><td>Corn grain</td><td>11.20</td><td>Corn grain</td><td>6.35</td></tr>
<tr><td rowspan="3">Warm season ration</td><td rowspan="3">Natural pastures</td><td rowspan="3">100</td><td rowspan="2">Soybean meal</td><td rowspan="2">8.40</td><td>Triticale grains</td><td>4.54</td></tr>
<tr><td>Soybean meal</td><td>7.26</td></tr>
<tr><td>Supplements</td><td>2</td><td>Supplements</td><td>1.87</td></tr>
<tr><td>Free grazing</td><td colspan="3">In warm season</td><td colspan="2">Not</td><td colspan="2">Not</td></tr>
<tr><td>Number of meals</td><td colspan="3">2</td><td colspan="2">2</td><td colspan="2">2</td></tr>
<tr><td>Feed administration</td><td colspan="3">Manually</td><td colspan="2">Technological trailer</td><td colspan="2">Technological trailer</td></tr>
</table>

Table 2. Information obtained by assessing the specificity and organization of the feed base in the monitored farms (continuation)

	Farms		
	A	B	C
Adaptation of the ration according to the physiological status of the animals	Yes - Gestation - elimination of CS	Yes - Gestation - elimination of CS - reduction to ½ of the proportion of concentrates	Yes - Ration administered on productive levels (preparation, lactation/parturition, breast rest) - changing the proportions of concentrates and silage
Feed origin (own production)	Cold season ration - 50%	75%	71%
	Warm season ration - 100%		
Quality analysis of feed	To third parties	Own laboratory	Own laboratory
Harvesting, processing	May - August	May - October	May - October
	Manually + Mechanized	Mechanized	Mechanized
Crops: applied treatments and rotation	3-11 ha 700-1100 m altitude Natural fertilizer Monoculture	8-25 ha Monoculture ** at 4 years – alfalfa Fertilization: N;S,P/ Crop protection – herbicides	20-100 ha Monoculture ** at 4 years – alfalfa Fertilization: N; P, Cu, Mn, Zn / Crop protection – herbicides, pesticides, fungicides, insecticides
Feed storage	Type of storage (closed wood storage type and open cell storage type)	Type of storage (open type warehouses, open cell storage type, closed type deposits)	
Unconventional water sources	Warm season (grazing)	Not	Not
Animal and shelter care / Substances used	Current sanitation actions	Current sanitation actions: Milking parlors: substances based on $C_3H_6O_3$, CH_3COOH, $C_2H_4O_3$, H_2O_2, NaOH, KOH, NaClO Animals: substances based on $C_3H_6O_3$	

***crop rotation for alfalfa.*

In the literature, Aytenfsu et al. (2016) mentioned the importance of the breeding system for assessing the possibility of exogenous contamination of feed and milk, therefore, highlighting the system of breeding and maintenance of animals in relation to the study of pollutants, found its applicability for assessing the possibility of accidental contamination of feed and animal production, in the shelter area, in the food storage area or during transport.

The indications regarding the geographical area of each farm, correlated with the environmental conditions in the targeted area (temperature, wind direction) highlighted the position of farm B and of farm C on the dominant wind direction, which can be an additional way of contamination with pollutants generated from neighborhood sources.

The evaluation of the feed base of each farm showed that all three farms have a feed base provided mainly from their own vegetable production, which, in the context of the study, highlights the possibility of a more rigorous control of feed production and allows further study of the traceability of pollutants.

At the same time, the evaluation of the farms showed that the complexity of the feed bases of the three farms analyzed and the specificity of the animal feed (Figure 2) changed in proportion to the intensification of the farming system applied. In the analyzed context, for farm A a less developed feed base was highlighted, with seasonal ration and the majority of feed obtained on its own, which, in the context of the study, shows that the risk of contamination within it is lower compared to other two farms analyzed (B and C). The diversification of feed bases, specific to farm B (rural area) and farm C (urban area), as well as the predominant mechanization of operations, bring to the fore the possibility of a higher level of pollution than in the case of farm A (rural area, mountain); these details are also relevant for the study of the traceability of pollutants, because, within the same farms (B; C), a higher proportion of feed is obtained from external sources, thus being more difficult to assess in terms of monitoring pollutants.

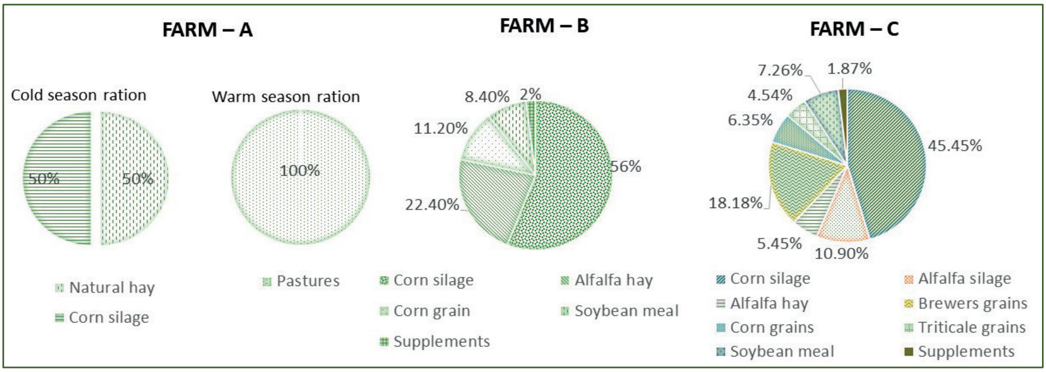

Figure 2. Type of feed and proportion of ration

Particularly important in determining the incidence of feed and milk pollution, the identification of the main sources of pollution for all the farms analyzed allowed the monitoring of certain types of pollutants whose presence is predominant, in accordance with the identified issues in Table 3. The forms of pollution found has included stationary sources, such as positioning in a former mining area, as is the case of farm A, important, given the persistence of some of the pollutants in the environment; mobile sources such as transport or industrial activities, common to the farm B and C, but also various agricultural activities with potential pollutants (application of potentially polluting substances), especially for the farms B and C.

Table 3. Sources of pollution identified in the vicinity of the farms

FARM			A	B	C	GENERATED POLLUTANTS
Location and expected level of pollution			*Mountain* 47°34′N, 25°19′E	*Rural* 47.21° N, 27.50° E	*Urban* 47°09′N, 27°39′E	
POLLUTION SOURCES			-			
Stationary sources	Waste combustion				●	PCB, HCB, PCDD/F, PAH, Cd, Cr, Cu, Hg, Zn
	Chemical and steel industry				●	As, Cd, Cr, Cu, Fe, Mo, Ni, Pb
	Mining activity		●			Cd, Cu, Fe, Hg, Mn, Ni, Pb, Zn
Mobile and surface sources	Road transport (car aerosols, tire wire)			●	●	As, Cd, Co, Mn, Ni, Pb, Zn
	Airline (landing-take-off cycles)				●	Cd, Mn, Ni, PCDD/F
	Construction industry				●	Cd, HCB, Pb, PCB
	Wastewater treatment plant				●	Cd, Cu, Fe
Agricultural activities	Organic fertilizers / Compost		●	●	●	Cd, Cr, Cu, Fe, Hg, Mn, Mo,Ni, Pb, Zn
	Treatments applied to crops	Mineral fertilizers		●	●	Cd, Cu, Mo, Pb, Zn
		Pesticides			●	Cu, Hg, OCP, Pb, Zn
CONTAMINATION FACTORS			-			
Free grazing			●			-
Unconventional sources of water			●			
Fedd from third parties				●	●	
Chemicals for the care of animale, shelters and facilities				●	●	

HCB=*hexachlorobenzene;* ***OCP***=*organochlorine pesticides;* ***PAH***=*polycyclic aromatic hydrocarbons;* ***PCDD/F***=*polychlorinated dibenzo-p-dioxins* ***(D)****/furans* ***(F)****;* ***PCB***=*polychlorinated biphenylene.*

Consistent with the issues highlighted by Ukaogo et al. (2020), the sources mentioned in Table 3 reported as main potential pollutants generated the persistent organic compounds and heavy metals, which subscribes to other research in the same field (Shafy & Mansour, 2016; Kulkarni et al., 2019; Senthikumar & Naven Kumar, 2020).

Table 4. Chemical treatments applied to vegetable crops

	Vegetal product	Type of treatment	Commercial formula	Quantity/ha	Active substance
B	Alfalfa	Weed control (herbicide)	Pulsar 40	1.1 L	40 g/L Imazamox
	Corn for silage	Fertilization	Sulfammo–25–MPPA–1	170 kg	25% N (18 % N amoniacal; 7% N nitric); 31% SO_3; 2% MgO
		Weed control (herbicide)	Principal Plus	440 g	9.2% Nicosulfuron; 55% Dicamba; 2.3% Rimsulfuron
	Corn for grain	Fertilization	DAP 18–46–0	250 kg	18% NH_4; 46% P_2O_5
			Sulfammo–25–MPPA–1	250 kg	25% N (18% N amoniacal; 7% N nitric); 31% SO_3; 2% MgO
		Weed control (herbicide)	Principal Plus	440 g	9.2% Nicosulfuron; 55% Dicamba; 2.3% Rimsulfuron
C	Corn for silage *and* Corn for grain	Fertilization	Uree	100 kg	$CO(NH_2)_2$
			Complex Azomures NPK 20–20–0 vq	100 kg	20% N total; 20% P_2O_5 total; 60% P_2O_5 water soluble; 98% P_2O_5 soluble in citric acid 2%; max. 0,6% water
			Nitrocalcar	150 kg	27% N; 7% CaO; 5% MgO
		Weed control (herbicide)	Henik	1.5 L	40 g/L Nicosulfuron
			Mustang	0.6 L	6.25% Florasulfam; 30% Acid 2,4D EHE
			Adengo	0.4 L	225 g/L Isoxaflutole; 90 g/L Tiencarbazon-methyl; 150 g/L Cyprosulfamide (safener)
	Alfalfa	Fertilization	Complex 16–16–16	250 kg	16:16:16 N:P:K
		Weed control (herbicide)	Corum	1.2 L	480 g/L Bentazon 22.4 g/L Imazamox
	Triticale	Fertilization	Uree	150 kg	$CO(NH_2)_2$
			Nitrocalcar	150 kg	27 % N; 7 % CaO; 5 % MgO
		Fertilization	Lebosol – Mix Cereale	1.5 L	1.6% Cu – $Cu_2Cl(OH)_3$ 25 g/L; 11.5% Mn – MnO_2 183 g/L; 4.9% Zn – ZnO 78 g/L.
		Weed control (herbicide)	Pixxaro Super	0.3 L	12 g/L Halauxifen-methyl; 280 g/L Fluroxipir mepthyl; 12 g/L Cloquintocet-mexil
		Fungi control (fungicide)	Orius	0.5 L	250 g/L Tebuconazol
			Falcon Pro	0.5 L	53 g/L Protioconazol; 224 g/L Spiro-xamină;148 g/L Tebuconazol
		Insect control (insecticide)	Mospilan	0.15 L	20% Acetamiprid

Relevant for the study of pollutants, variable factors for contamination were identified (Figure 3): the presence of free grazing and unconventional water sources in the vicinity of pastures (farm A); intensification of agricultural activities; an important percentage of feed from external sources or use of chemical substances for the care of animals or for shelters (farm B and C).

Given that the modernization of agriculture has led to an increase in chemical treatments applied to crops (Chavoshani et al., 2020) and, taking into account the particularities related to the possibility of accumulation and persistence of various pollutants in the soil, monitoring the potential level of feed pollution aimed how to obtain crop production in terms of treatments applied or crop rotation, highlighting in general as potentially harmful actions the use of natural fertilizer-farm A, dangerous due to the fact that there is no control over their components or the application of various fertilizers on base of N, P, K and various chemical treatments to control weeds or pests (Table 4).

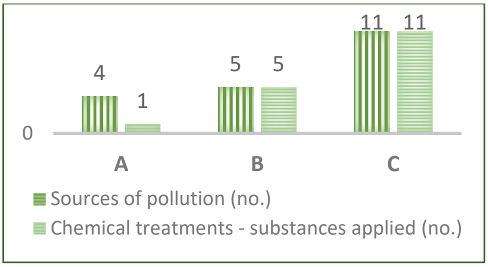

Figure 3. Evaluation of potential polluting level

Following the general characterization and assessment of the analyzed farms, but also following the identification of the main sources of pollution in their vicinity, the farms were grouped according to potential levels of pollution. Given the application of a semi-intensive growth system and also the location in an area devoid of important sources of pollution, farm A was considered to have a low potential level of pollution. Regarding farm B, given its position in the vicinity of one of the most polluted cities in the country, but also the location of the main pollution sources from the urban area on the dominant wind direction (NW-SE), the farm was classified as having a medium level of potential pollution.

In contrast to the other two farms, for farm C, the expected pollutant level is not only given by the positioning in the vicinity of the city, but is amplified by the concentration of many industrial factories in the vicinity of the farm, as well as the existence of intense air transport activities, activities in the field of construction or road infrastructure, which means that farm C is considered to have the highest potential level of pollution.

CONCLUSIONS

Following the monitoring of the specific activity of the analyzed farms, focused on the study of feed bases in relation to the assessment of the potential pollution level of feed and milk, it was highlighted that all actions carried out on a farm are relevant in the study of feed pollution and animal production pollution, offering as a whole, the possibility of a continuous assessment of the relationship between the environment, animal husbandry, feed safety and animal production.

The information obtained allowed grouping the studied farms into categories, depending on the expected level of exposure to pollution: L–low level; M–medium level; H–high level.

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